GOVERNMENT OF NCT OF DELHI
DEPARTMENT OF FOREST AND WILDLIFE
VIKAS BHAWAN, A-BLOCK, 2ND FLOOR, I.P. ESTATE, NEW DELHI-110002.

F.No.107/CWLW/NJ/CSI/2022/6686 Dated: 30/8/22

PUBLIC NOTICE

Request for Proposal with estimates for 'Commissioning Species Inventory' - regarding.

As per the order dated 17.09.2020 of Hon'ble NGT, in EA No. 16/2019 in OA No. 153/2014, Govt. of Delhi and Haryana have been directed to submit an Environment Management Plan (EMP) for conservation and rejuvenation of Najafgarh Jheel. Accordingly, the Wetland Authority of Delhi with the help of an Expert Committee prepared Environment Management Plan (EMP) which was accepted by the Govt. of Delhi, and was submitted to the Hon'ble NGT.

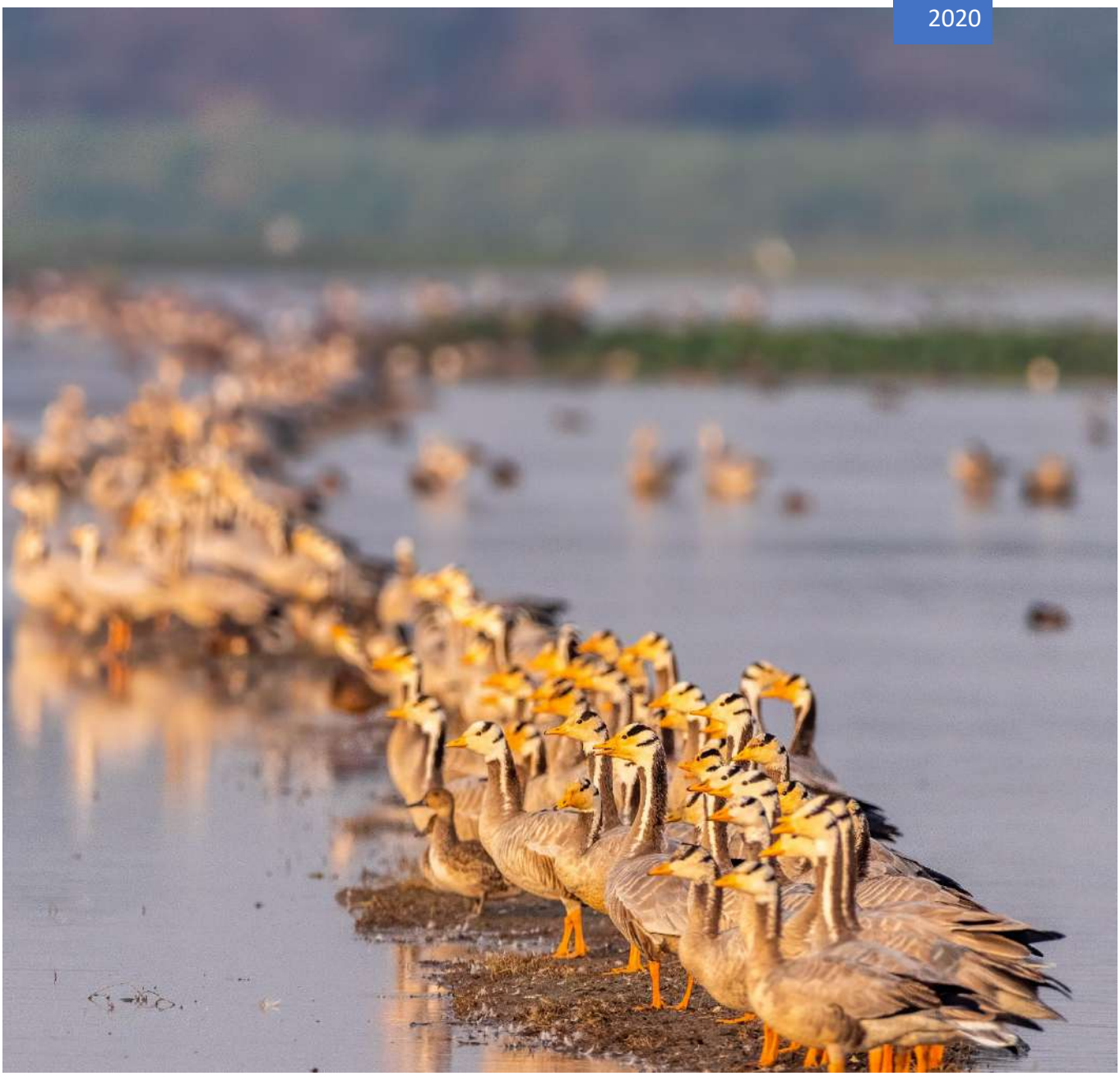
In this regard, the Department of Forests & Wildlife, GNCTD intends to prepare an inventory of the species found in or dependent on the Najafgarh Jheel. You are hereby requested to express your interest for conducting the study latest by 30.09.2022 and if agreed, submit a proposal including financial implications of the project at the earliest.

A copy of the framework of EMP of Najafgarh Jheel is also attached for your kind reference.

Encl: As above

(Abhinav Kumar)
Dy. Conservator of Forests (HQ)/ Wildlife Officer

2020



Najafgarh Jheel

a framework environment management plan

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Cover Photo: migratory Bar-headed geese at Najafgarh Jheel by Gautam Kashyap

1. Najafgarh Jheel – the Management Context

1.1 Najafgarh Jheel, a transboundary wetland shared between Haryana and NCT of Delhi, is a critical natural infrastructure for the region, buffering floods, treating wastewater, recharging groundwater and providing habitat to numerous plant and animal species, including diverse migratory and resident waterbirds. Despite being source of critical benefits and sustaining high biological diversity, the wetland has been highly fragmented and transformed, used as a waste receptacle, and infested with invasive species. The Wetland Authority of NCT of Delhi, in compliance with the directions of Hon'ble National Green Tribunal constituted an expert committee vide order dated October 29, 2020 to: a) recommend contour levels and delineated maps of Najafgarh Jheel and its zone of influence for notification under Wetlands (Conservation and Management) Rules, 2017 and recommend an Environment Management Plan including prohibited and regulated activities (order and constitution of expert committee at Annex 1). The plan was drafted by a team comprising Dr Manu Bhatnagar (Principal Director, Natural Heritage Division, INTACH), Ms Neha Sinha (Conservation and Policy Officer, Bombay Natural History Society) and Dr Ritesh Kumar (Director, Wetlands International South Asia).

1.2 This Environment Management Plan responds to the terms of reference of the expert committee. In framing this plan, the committee has referred to existing reports (notably, the booklet – Najafgarh Jheel prepared by INTACH in 2018, a detailed note on status of Najafgarh Jheel and Action Plan for its Preservation and Wetland and Restoration by Prof C R Babu), and maps, satellite images and datasets made available by various agencies. A field-visit to the wetland was also made on November 11, 2020. The plan uses the management planning guidance of the National Plan for Aquatic Ecosystems of the Ministry of Environment, Forest and Climate Change as the reference framework.

1.3 The expert committee refers to this document as a framework plan to be used as a guide for developing a comprehensive management plan based on a diagnostic evaluation of wetland features and related biodiversity and their governing factors, involving a multidisciplinary expert team and extensive stakeholder consultations. The plan also provides a basis of wetland demarcation for the purpose of notification under Wetlands (Conservation and Management) Rules, 2017. Given that this is an interstate wetland, the committee is also of the opinion that this document is consulted with Wetland Authority of Government of Haryana, and shared vision on management objectives, actions, monitoring mechanisms and institutional arrangements is developed.

Wetland extent

1.4 Straddling the border of Haryana and NCT of Delhi, the Najafgarh Jheel is a large wetland located in the Sahibi River Basin which spans 10,611 km^2 across Rajasthan, Haryana and NCT Delhi (Map 1). The wetland forms part of the course of the Sahibi River and is depicted in the maps of 1803, 1807, 1936, 1964, 1975, 1984, 1996, 2010 [Survey of India] and can be readily seen as an interstate waterbody in various satellite images. It is also mentioned on p.94 of National Wetland Atlas [Haryana State], 2011, and as per the February 8, 2017 directions of the Supreme Court in matter related to Writ Petition(s)(Civil) No(s). 230/2001 is to be notified under the provisions of Wetlands (Conservation and Management) Rules, 2017.

1.5 The current wetland regime is a fragment of large expanse, which was noted in the Delhi Gazetteer, 1883, as having a spread of 88 sq.miles [226 km^{2}or 56500 acres] based on the Revenue Settlement Records [Maconachie, 1880]. In 1865 the Govt. of the North-West

Province [later United Provinces] started draining the Jheel by excavating and widening the channel of Sahibi from the eastern end of the Jheel to the Yamuna. This channel then came to be known as the Najafgarh Nala or Najafgarh Drain having a length of 51 km in UT of Delhi.

1.6 Being a shallow depression in a large catchment and with constricted outfall, the area surrounding the wetland is recurrently flooded. Floods are therefore a regular feature, and major floods have been recorded – 1958, 1964, 1977, 1988, 1995 with lesser floods in 1975, 1976, 1983, 1996, 2010, 2016 and even in 2020. Subsequently, after the floods of 1964, the Union Territory of Delhi built an embankment on its side of the Jheel to prevent inundation of its areas parting the Jheel into north and south segments. [Haryana cannot similarly do so as this is the only route for escape of flood waters from Gurugram to Yamuna River. Again, after the massive floods of 1977 the Najafgarh Drain was widened to accommodate the flood and Delhi started constructing the Supplementary Drain to carry the excessive flood discharge to the Yamuna. The construction of embankment has thus curtailed the natural flood pulses, and also triggered land use change, with large swathes brought under agriculture, and fringes for urban development.

1.7 Wetlands are defiend in the text of Ramsar Convention (to which India is a signatory) as ""areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres". Wetlands are delineated based on their key indicators- namely presence of permanent or intermittent inundation (alteast in excess of 15 days in a normal hydrological year), hydrophytes (of dominance above 50%), and saturated soil (with ground water levels less than 1 foot). A systematic delineation of wetland regime has not been done in case of Najafgarh Jheel, however the inundation patterns provide a robust indicator. The current regimes however are significantly modified by the embankment on the Delhi side, and operation of regulators at Dhansa (upstream of the wetland).

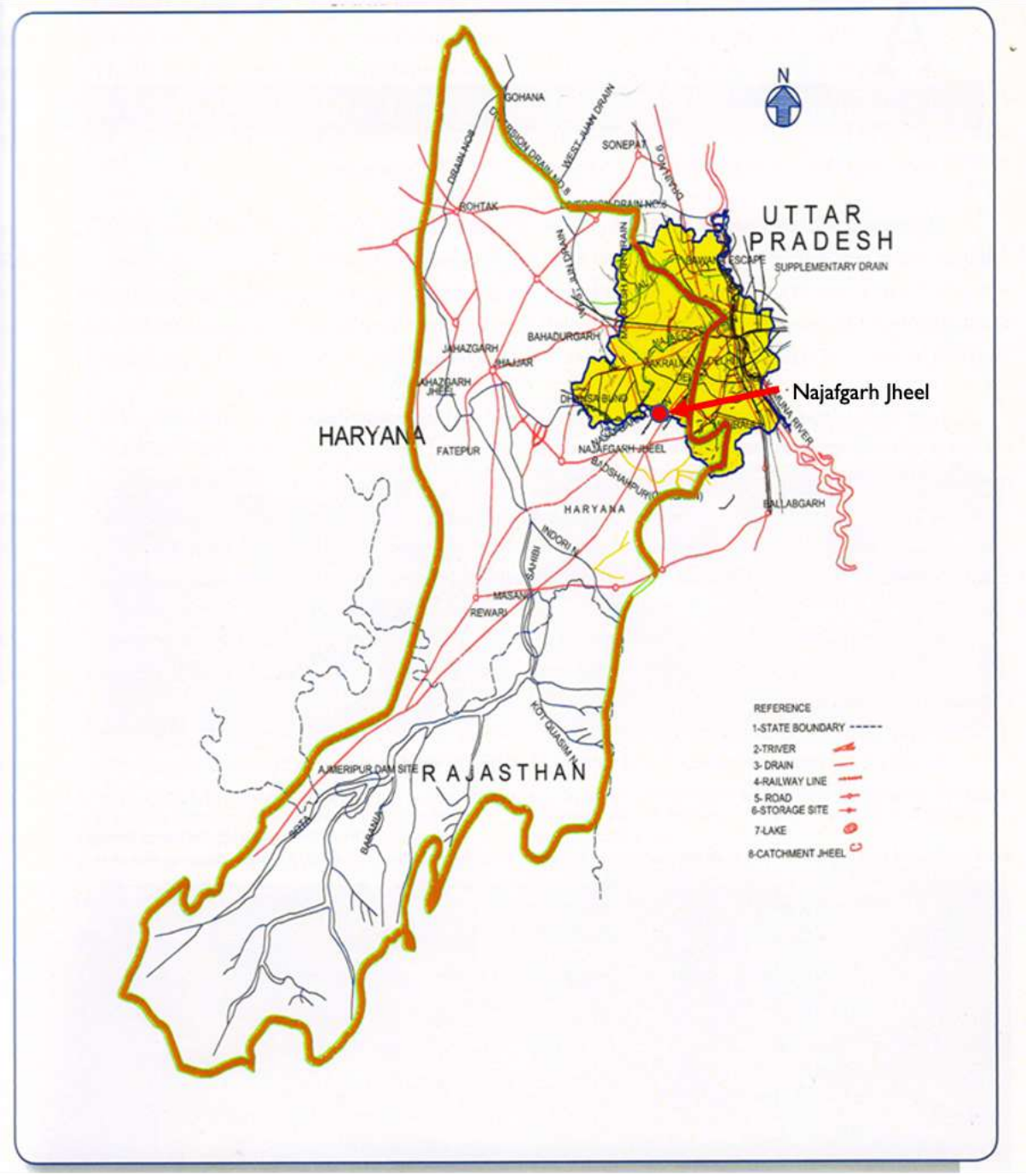
1.8 In flood years vast areas of the Najafgarh Jheel depression have been submerged. Thus, in 1958 the Jheel submerged 145 km^2 [14,500 ha] and in 1964 the Najafgarh Jheel attained a spread of 240 km^2. [Source: Irrigation and Flood Control Department, NCT of Delhi].

1.9 Data on the spread attained in 1977 is available, not in terms of area but in terms of contour levels reached by flood waters. The water levels are recorded at the depth gauges on various regulators and bridges by Dept. of Irrigation and Flood Control, Delhi [I & FC]. The following data regarding the 1977 [which may be taken as the once in a 100 year flood on the Sahibi] flood levels is available from I & FC website (Picture 1) :
"The max level recorded D/s of Dhansa regulator was 212.80 M (697.98 ft) on 9.8.77 and the max. level recorded at Kakraula was 212.125 M (695.77 ft) on 16.8.77 and the same level was recorded at Basaidara on 17.8.77. The rural area in Delhi remained under water for about 3½ months and were free from submersion only in the second week of November."

1.10 The water level data for 2010-2020 (Table 1) indicates that even in the regulated condition, the average maximum water level attained at Jhatikra bridge [immediately downstream of the Jheel] over the last 11 years has been 209.90 m amsl and average minimum level has been 208.75 m. These levels are the result of intense rainfall events in Gurgaon and SW Delhi and do not cater to the basin level events which can occur in any year. While there is an impression that there is hardly any flow in the Sahibi river due to several checkdams in the Rajasthan side upstream of Masani Barrage the northern part of the Sahibi catchment [downstream of Masani Barrage], amounting to some 5000 sq.km., is capable of generating massive inflows, well beyond the water holding capacity of the Jheel.

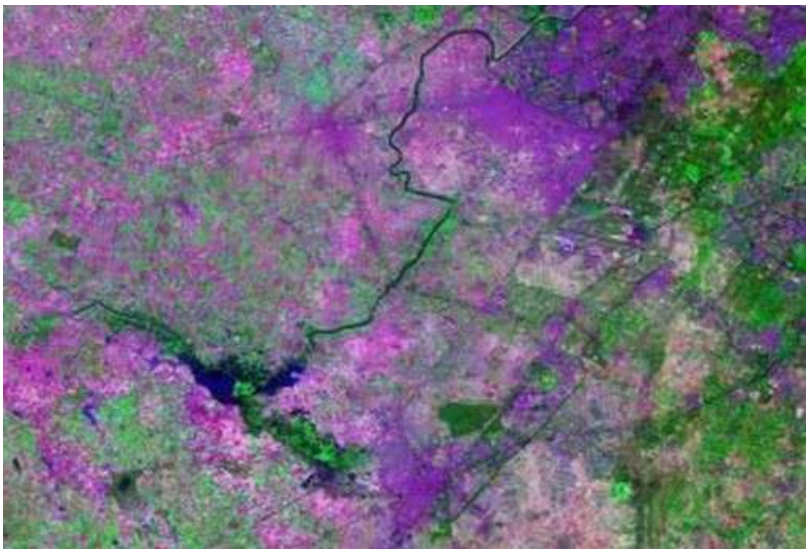
Table 1. Water level and discharge of Najafgarh Drain upstream and downstream of Najafgarh Jheel

NAJAFGARH DRAIN								
YEAR	RAINFALL (mm)		DHANSA DISCHARGE (Cusec)		DHANSA REGULATOR (Level)		JHATIKRA (Level)	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
2010	5.40	98.80	364	1485	209.300	210.375	208.750	210.350
2011	2.10	62.20	13	330	209.275	209.800	208.500	209.750
2012	3.80	54.60	36	563	209.350	209.950	208.350	209.725
2013	2.40	83.60	7	653	209.250	210.000	208.750	209.925
2014	6.40	77.80	20	284	209.300	210.300	208.650	209.700
2015	1.60	62.40	36	330	209.350	209.800	208.800	209.700
2016	1.80	57.80	7	799	209.250	210.075	208.900	210.000
2017	3.20	26.20	36	158	209.250	209.950	208.750	209.625
2018	2.80	62.40	7	1365	209.250	210.325	208.900	210.125
2019	3.60	34.20	7	103	208.900	209.500	208.900	209.375
2020	3.20	102.60	144	2400	209.250	210.700	209.000	210.650



Map 1. Catchment of Sahibi River (Source: Irrigation and Flood Control Department, NCT Delhi)

Picture 1. Inundation of 1977 floods (Landsat MSS Imagery, Sinha et al, 2019)



Picture 2 Vast waterspread on Delhi side in 1999 (even as a result of localized high rainfall event)

Picture 3. Submergence patterns along Najafgarh Jheel (September 9, 2016) (Source: Sinha et al., 2019)

Picture 4. Inundation on August 20, 2020 on Delhi side (top left and right) and Haryana side (bottom left and right) (Credit: Ramesh Mumukushu)

Picture 4. Contour 212.5 m amsl (100 year flood level) overlaid on Gurgaon Master plan (2031))(several proposed sectors are in flood hazard and soil liquefaction zone)

Picture 5. Wetland areas wherever constructed upon are routinely under water. Left: Apartment in Sector 107 inundated; Right: Woodshire Apartments of Sector 108 Gurgaon having with basement and lower storeys inundated)

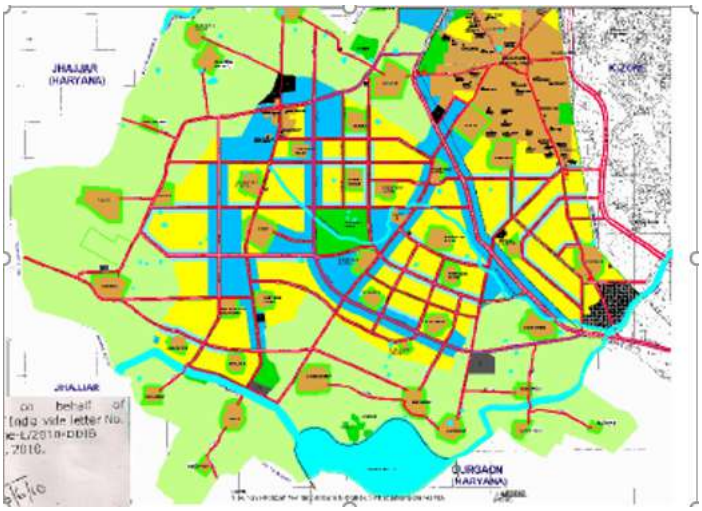


Figure 1. Zone L Plan of Master Plan of Delhi 2021 shows 356 ha [890 ha] as reserved for Najafgarh Jheel on Delhi side

1.11 Despite construction of an embankment on Delhi side, the area along the interstate boundary is inundated for months in all major flood events and the floodwaters overtop the embankments (Picture 2). At Raota village, according to I & FC, this year [2020] an area of 244 acres [nearly 1 sq.km.] was submerged., i.e. upto contour 210m amsl .

1.12 Despite rampant constructions, the area of wetland constructed upon in Haryana are routinely inundated (Picture 5).

1.13 On behalf of the NGTs context a visit was made to Najafgarh Jheel by a team consisting of Hon'ble Member of YMC, Shri. B. S. Sajwan, two Monitoring Committee Members of Haryana, Shri. M. D. Sinha, Additional CEO, Gurgaon Metropolitan Development Authority and his team, the Member Secretary of CPCB and his team, Irrigation Department of Haryana and HSPCB Members and Professor C. R. Babu of the University of Delhi. The visit was made on 25th January 2020. An excerpt from the report of Dr. Babu is reproduced below :

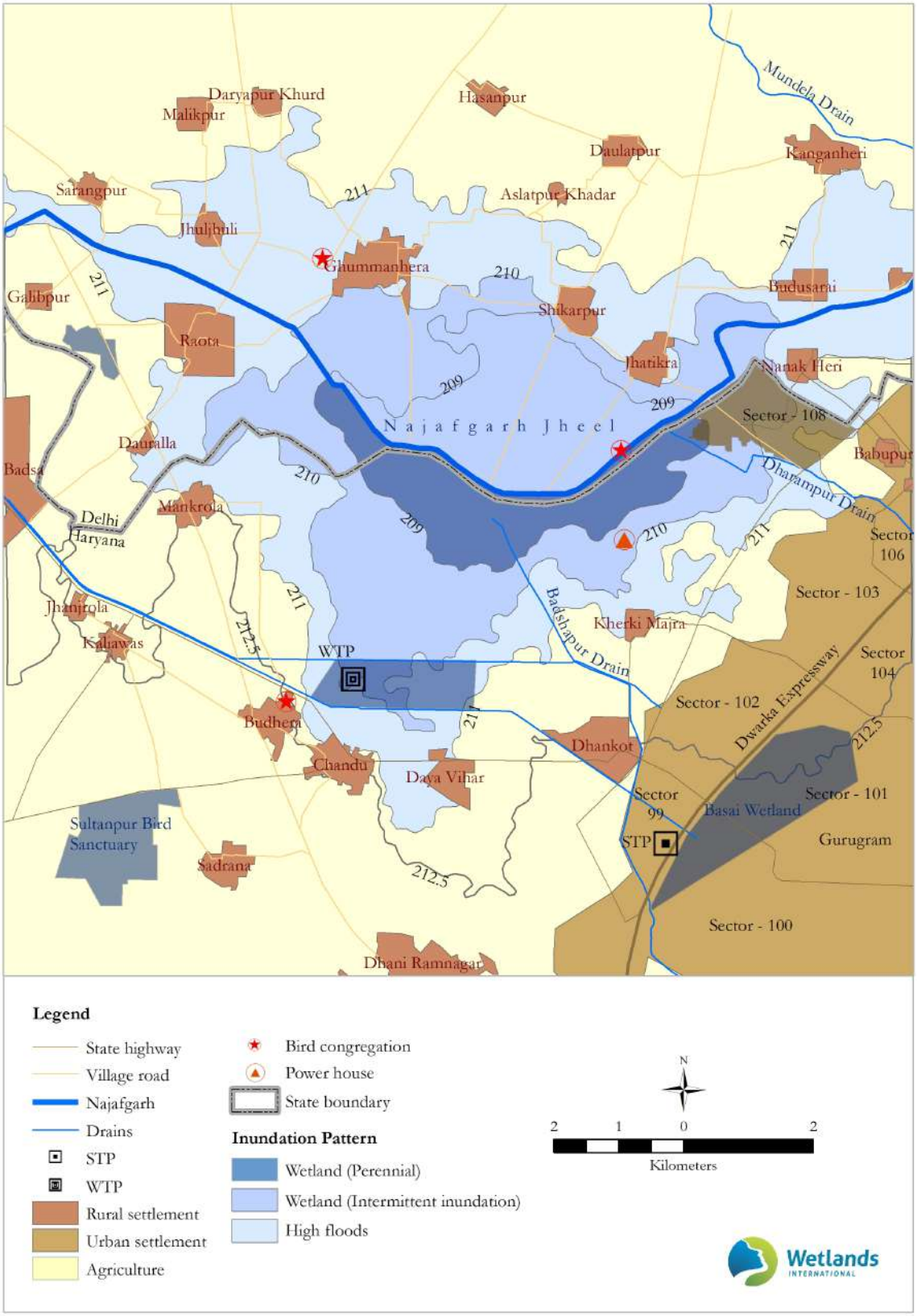
"The left out Najafgarh Jheel is the only landform that ensures the safety to Gurugram and Delhi from the massive floodwaters during heavy rainfall resulting from climate change. In fact, it was pointed out that the frequent water logging of Gurugram city roads and submergence of flats in the submergible area enclosed by 212 contour line is the rule rather than the exception (Figures 2&3). Sector 108 of Gurugram and neighbouring areas, which were flooded and submerged in 2010, have been brought under construction and are in the core flood zone. Najafgarh Jheel is the only safeguard for both the cities against climate change and adaptation to extreme events – extreme temperature and rainfall."

1.14 Based on the chronological record, map series, water level data and visual evidences presented above the core area of the Jheel may be delineated along contour 210 m amsl (Map 2). The area between contours 210 m amsl and 211 m amsl serve as the zone of influence, whereas the area uptil 212.5 m amsl is a zone of high floods. This delineation takes into account:

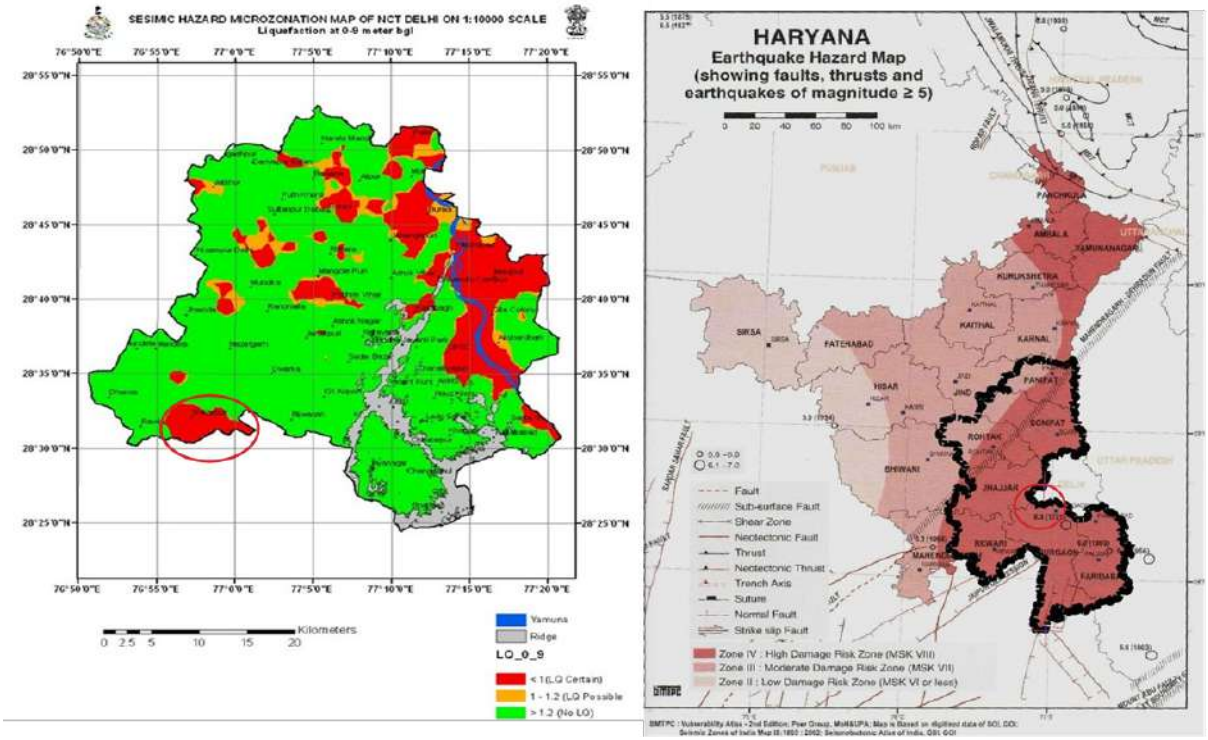
- Permanent and intermittent inundation areas, as well as the presence of hydrophytes.
- Zone L of the Masterplan of NCT Delhi which shows an area of 356 ha [890 acres] designated as Najafgarh Jheel (Figure 1). Masterplan also mandates that one revenue village depth along NCT Delhi boundary is to be maintained as green belt.
- The area excludes settlements, which have naturally developed on the edges of the inundation.
- SoI Map submitted by Government of Haryana in National Green Tribunal in August 2015
- Detailed contour mapping presented in report of Prof C R Babu (esepcially Picture 1 and 3)

1.15 Again, based on the record and evidences from the point of view of flood pulsation and public safety a two layer buffer zone is recommended. The first buffer will be provided by the zone of influence (area between 210 and 211 m amsl contours), and second buffer upto contour 212.5 m amsl but on the south-east side would be bounded by the Dwarka Expressway in Haryana. This will this provide a large flood absorption area, which is vital considering the recurring frequency of extreme events, especially die to changing climate. The embankment, which presently isolates natural flood pulses on the Delhi side, may need to be opened at placed to allow for prolonged inundation, and thus enable groundwater recharge. This may be crucial to cushion the already depleting groundwater reserves of the NCT region.

1.16 It is crucial that construction activity in and around the wetland region is completely curtailed given the high risk of liquefaction and earthquake hazards (Map 3).



Map 2. Najafgarh Jheel



Map 3. Seismic hazard maps for Delhi (left) and Haryana (right) (Haryana is still to carry out micro-zonation exercise, but clearly zone of liquefaction extends all around the Jheel area)

Figure 2. Upstream and downstream hydrological connectivity of Najafgarh Jheel

Hydrological and Ecological set up

1.17 The hydrological regimes of Najafgarh Jheel are influenced by the water and land management in the basin of Sahibi River (Fig 2) . The northern Haryana catchment lying in Rohtak, Jhajjar and Rewari Districts is generally sloping southwards and discharge surface runoff into the Najafgarh Jheel through Outfall Drain No.8 and Sahibi which have a common course of 24 sq.km. upstream of the Najafgarh Jheel. The southern catchment from Rajasthan and South-West Haryana slopes northwards and provides surface runoff to the Jheel through Sahibi [in years of heavy rainfall only]. Surface runoff and storm water inflows from Gurugram district provide major contribution to the Jheel in monsoons. NCT Delhi's segment of the basin is sloping southwards and provides surface runoff through sheet inflow to the Jheel. Major part of the catchment is in Rajasthan (65%) and Haryana (29%). The NCT of Delhi accounts for only 6% of the catchment area. Of the entire catchment, approximately 9,300 km2 area drains upstream of Najafgarh Jheel.

1.18 Water level measurements around Najafgarh Jheel are available for Dhansa Regulator (upstream) and Jhatikra (Downstream) (Fugure 3). Currently records are maintained only for monsoon period, wherein a variation between 209.25 m amsl and 210.75 m amsl can be seen at Dhansa Regulator. There is general gradient of about 15 cm per kilometer towards River Yamuna.

Figure 3. Water level variation upstream and downstream of Najafgarh Jheel (20200 (Data source: Irrigation and Flood control Department, NCT of Delhi)

1.19 The wetland, at 210 m amsl inundation has a waterholding capacity of 27.5 m MCM (Figure 3). Maintenance, and enhancement of this capacity is crucial for flood buffering and groundwater recharge functions.

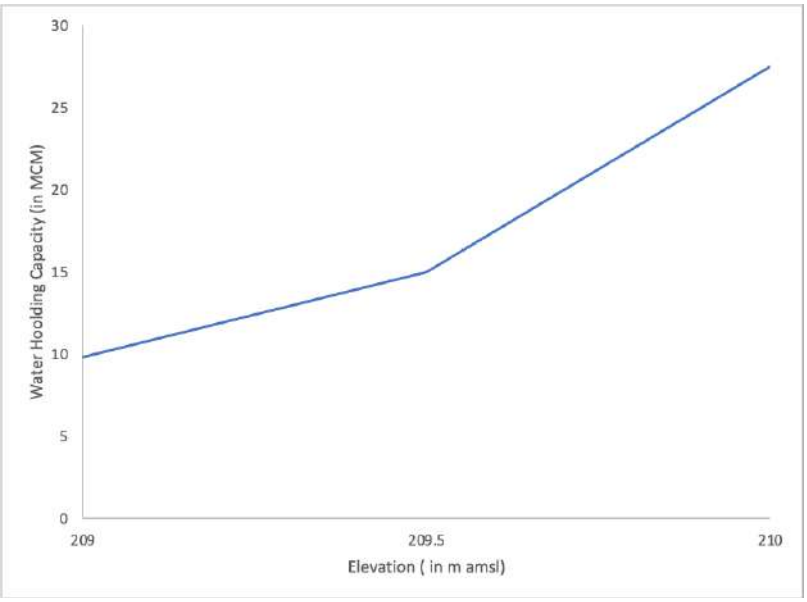


Figure 4. Water holding capacity of Najafgarh Jheel (projected)

1.20 The Rajasthan segment of the basin has hardly contributed flow in recent years with their various retention structures and other interventions holding back waters. The possibility of occurrence of widespread rainfall of high intensity taking place cannot be ignored.

1.21 The average annual rainfall in the 5 basin districts is approximately 600 mm. With an average slope of 4% over a mixed urban and agricultural basin [with a sandy loam soil] such a rainfall a 10% runoff coefficient can be assumed [Source: Irrigation Engineering and Hydraulic Structures by S.K. Garg (2004]. Annually, the runoff generated by the Haryana and NCT Delhi basin segments [2400 sq.km.] alone would amount to 144 MCM.

1.22 Of late intense rainfall events of >100mm in a few hours have occurred every 3rd year. Such occurrences can be localized or widespread. Both scenarios are considered here :

I. Widespread 100mm + rainfall in the course of a day would generate a surface runoff of 30% or 72 MCM [2400 sq.km. x 100mm x 30%]

II. Localized rainfall of 100mm + in the course of a single day falling over NCT Delhi basin segment [100 sq.km.] and Gurgaon [urban area + Manesar + rural belt in between = 300 sq.km.] would generate a surface runoff of 20 MCM [400 sq.km. x 100mm x 50%]

1.23 In addition there is a small but continuous discharge from Dhansa Regulator which is unquantified but contributes to the Jheel spread.

1.24 The Najafgarh Jheel receives a continuous input of sewage from Gurgaon as well as surrounding villages of Delhi. Presently, Gurugram is generating 300 MLD [0.3 MCM] of raw sewage whereas the official projections are 533 MLD for 2021.

> "Estimates of how much sewage Gurugram produces vary. One set of data says the city generates about 225 MLD of sewage, and its treatment plants can process only 148 MLD. In 2007, the official estimate put the quantum of sewage generation at 129.6 MLD while the Joint Association of Federation of Residents Welfare Associations (JAFRA) estimated it to be about 260 MLD. The official forecast for the

year 2021 projects sewage generation of 533 MLD, but JAFRA projects a figure of 864 MLD" – 'Gurugram : A Framework For Sustainable Development' by CSE, 2017

1.25 The daily percolation in the core zone [Gurgaon and NCT Delhi] may be assumed at 5mm column per day. In summers the daily evaporation loss is 1.5 cm column and in winters 0.5 cm column. Taken together the daily loss in May would be 2 cm column and in December 1 cm column. In volumetric terms the same amounts to for contour 209m amsl :

- In May : 131 MLD [0.13 MCM]
- In December : 65.5 MLD [0.065 MCM]

1.26 In due course treated wastewater flows from NCT Delhi side would also be available for discharge through the Jheel.

1.27 The Najafgarh Jheel region has high groundwater levels (Figure 4) indicating significant role of groundwater in sustaining the wetland regime. In the NCT Delhi groundwater map the Jheel area has a high water table particularly on its upstream [west] end in the Raota village area. The water table surface is having an elevation of 208 m amsl whereas the central portion of the Jheel has an elevation of 206 m amsl and thus groundwater discharge from this side may contribute to the Jheel storage. With regards to Gurgaon it is well known that the water table has fallen considerably in the general area. However, in the Jheel area and its vicinity the water table is quite high with the available data indicating that the water table here is between 1-10 mbgl. Thus, the possibility of return groundwater flow contribution cannot be ruled out.

1.28 The wetland is shallow, with depths at the center upto 1.5 meters. Aquatic vegetation is well established on the Haryana side, with Phragmites stands on the margin and water hyacinth along the central areas.

1.29 Continuous discharge of sewage into the wetland has led to poor water quality conditions. Native vegetation is nearly absent, and dead vegetation patches and luxuriant growth of water hyacinth may indicate toxicity.

Table 2. Water quality of Najafgarh Jheel (Date of Sampling: November 9, 2020) (Data Source: Delhi Pollution Control Committee)

Sampling location	pH	TSS	COD	BOD
Dhansa regulator	7.1	4	8	1.6
Najafgarh Jheel	7.5	8	52	5
Najafgarh Jheel downstream	7.3	12	48	8

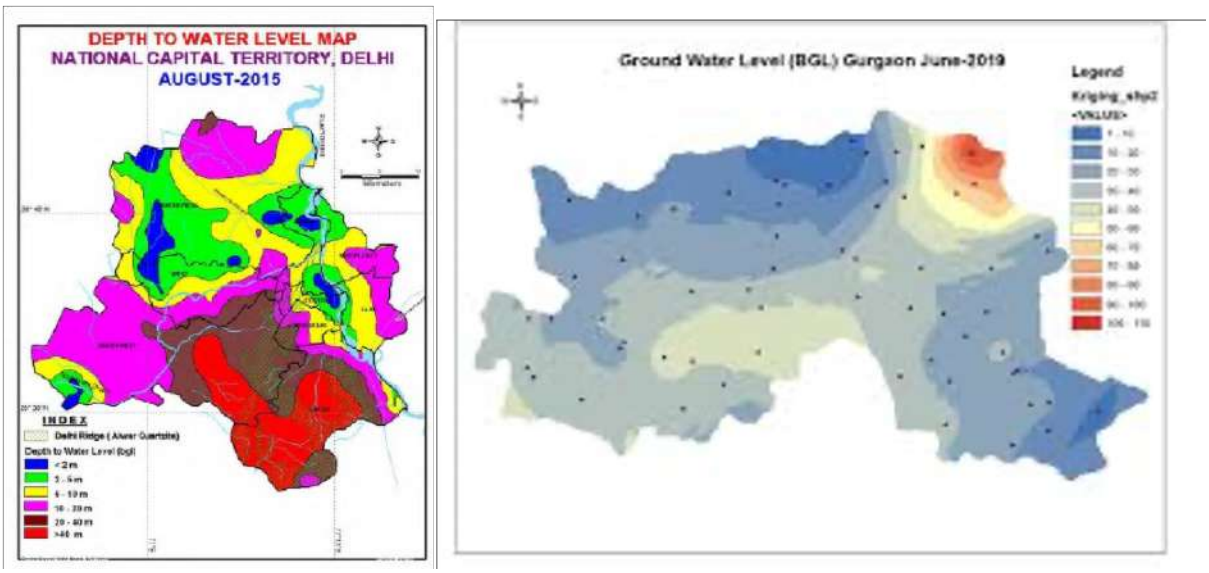


Figure 5. Groundwater levels are high in the region around Najafgarh Jheel as can be seen from depth to water level maps of Delhi (left) and Gurgaon (right)

Picture 6. A herenory of Cormorants at Najafgarh Jheel

Picture 6: An Imperial Eagle, a threatened and migratory species at Najafgarh in 2020. Photo by Bhrigu Kumar

Biodiversity values

1.30 The Najafgarh Jheel is a habitat of range of biota, several of high conservation significance, globally and nationally. A comprehensive inventory is yet to be prepared, and much of available information pertains to few groups.

1.31 Najafgarh Jheel is inhabited by atleast 281 bird species. these include resident species, migratory species, land birds, waterbirds, and birds of prey. This is likely to be Delhi's most important bird site. The area also has rich butterfly and dragonfly diversity [details in annexe]. A healthy dragonfly diversity is the mark of a good wetland. Abundance of dragonfly numbers also leads to control of mosquito populations.

1.32 Threatened species found in Najafgarh Jheel include Egyptian vulture, Sarus Crane, Steppe Eagle, Greater Spotted Eagle, Imperial Eagle.

1.33

1.34 It is desirable to create a full species inventory for the area, with the following: a) survey and inventory of vegetation—trees, shrubs and plants. b) survey and inventory of hydrophytes and aquatic plants c) creation of butterfly list d) creation of dragonfly list e) further inventory of bird lists.

1.35 The is inhabited by several resident species but is notable for the fact that a group of Greater Flamingos is here all year round in the wetland. This makes Najafgarh one of only two places in Delhi to regularly have Greater Flamingos (the other is Okhla bird sanctuary in the Delhi-UP border).

1.36 Many migratory birds species come to Najafgarh. These include large groups of waterbirds like Ruffs and Bar-headed goose. Najafgarh wetland also gets raptors (birds of prey) which travel from the Central Asian Flyway – coming to India from Central Asia, like the Steppe eagle and the Greater Spotted Eagle. The Greater Spotted Eagle is listed as 'Vulnerable' as per the IUCN red list. The Steppe eagle is listed as 'Endangered' as per the IUCN red list. The wetland also serves as habitat for landbirds that migrate here. Examples include the Wryneck, which is a kind of woodpecker that comes from Eurasia to Najafgarh.

1.37 Najafgarh Jheel has become an important heronry. Birds like Darter, Cormorants, Cattle Egrets and Ibis breed on large trees here (personal observation). More than 200 nests have been counted here. In this context, Delhi can assume a leadership role by declaring Najafgarh a wetland and protecting it as such. This will help India fulfil its commitments under the Convention on Migratory Species.

Picture 7: Migratory Black-tailed Godwits at Najafgarh. Photo by Bhrigu Kumar

1.38 Records of Asian Waterbird Census indicate that the wetland has regularly supported 30-40 waterbird species and counts upwards of 6,000 in the last five years (Figure 5). More than 10,000 birds were counted in 2020.

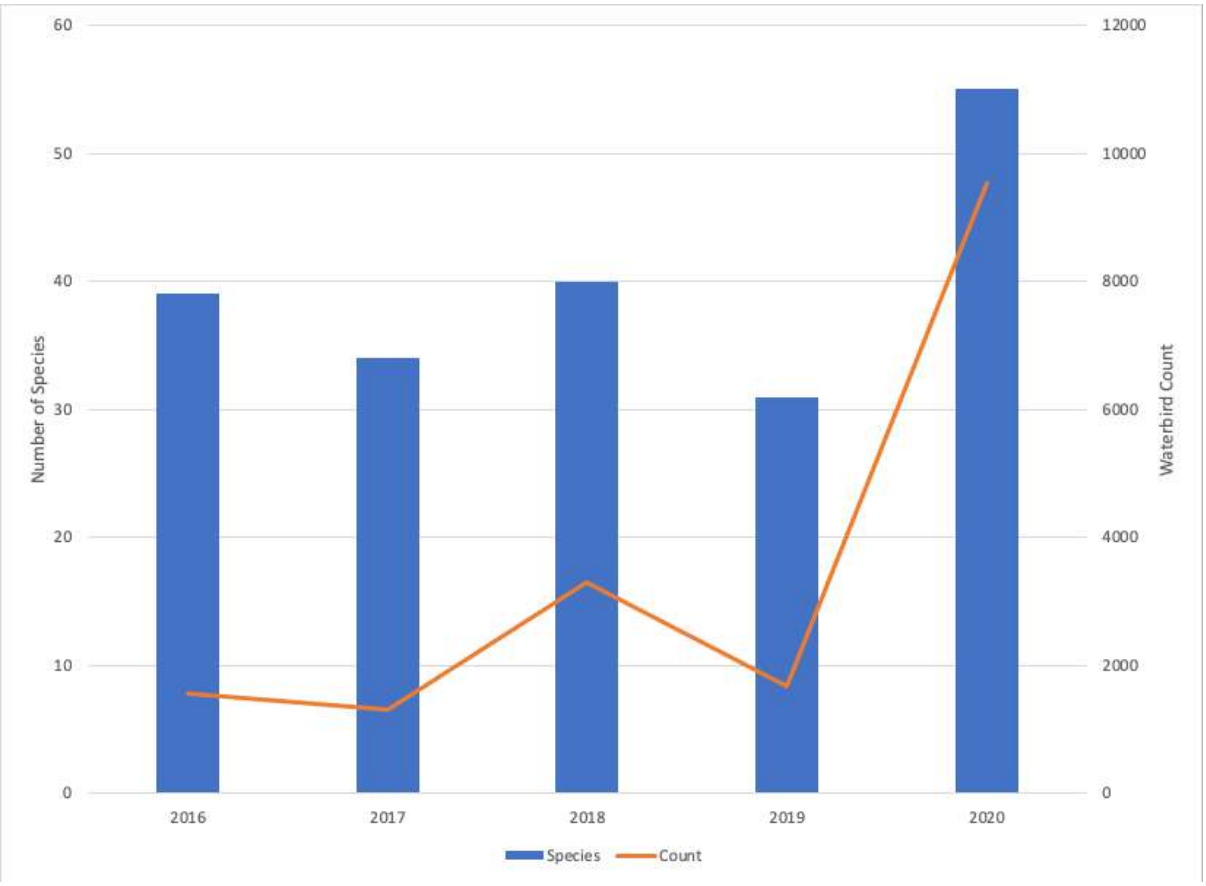


Figure 6. Waterbird species and counts recorded in Asian Waterbird Census (Data Source: Wetlands International South Asia and Bombay Natural History Society)

Ecosystem Services

1.39 The Najafgarh Jheel serves as a flood buffer for Gurgaon and Delhi. The natural drainage pattern in the region is towards the wetland. With increasing runoff due to built up areas, and increase in pluvial flooding linked with extreme events, the buffer function is critical defense for these areas.

1.40 In absence on sufficient wastewater treatment capacity, the wetland vegetation serves as sink for nutrients and heavy metals, in absence of which the water quality is likely to be further degraded. The wetland thus saves the neighbouring catchment water treatment costs.

1.41 The shallow water spread allows for groundwater recharge.

1.42 The Jheel renders high aesthetic value to the entire region. This in fact has been a major driver of property development especially on the Gurgaon side, also aided in part by weak land regulation.

2. Major threats and management needs

2.1 Extensive land use change aided by hydrological fragmentation: The natural inundation regimes of Najafgarh Jheel have been fragmented by upstream water diversions and construction of embankment along the left margin. On the Delhi side, the grasslands which prevailed in the sixties have been cleared for agriculture. On the Gurgaon side, the wetland margins have been developed for settlements and agriculture.

2.2 Pollution: The wetland hydrology is no longer governed by Sahibi River catchment flows, but from sewage discharged from Gurgaon and Delhi. This includes industrial effluents discharged from Manesar. The wetland has thus become a receptacle of wastewater.

2.3 Sedimentation: Low gradients, hydrological fragmentation and absence of flushing flows have led to sedimentation, particularly along the peripheral areas. This has been further aided by colonization of emergent.

2.4 Linear infrastructure: The wetland regime is criss-crossed by number of roads and other infrastructure such as power station. High voltage power lines in a habitat of migratory waterbirds are also highly concerning.

3. Existing institutional arrangements, gaps and proposed arrangements for management

3.1 Effective institutional arrangements, with capability of steering decision-making for wetlands conservation and wise use, and addressing direct and indirect drivers of adverse change, are a necessary pre-condition for integrated wetlands management. In the case of Najafgarh Jheel, there is no single entity entrusted with wetlands conservation and wise use, thus creating an institutional void which has been exploited to encroach, degrade and convert this ecologically-fragile region for alternate usages.

3.2 A number of central government acts and rules contain provisions relevant for conservation of Najafgarh Jheel. In 2017, the Ministry notified the Wetlands (Conservation and Management) Rules under The Environment (Protection) Act, 1986. As per these rules, the ultimate responsibility of securing Najafgarh Jheel rests with the Wetland Authorities of the governments of Haryana and NCT Delhi. The Authorities are expected to take necessary measures for delineation of the wetland boundaries and its zone of influence, demarcation on ground using appropriate mechanisms (such as placing boundary pillars), specifying regulation (activities prohibited, regulated and permitted within the wetland and its zone of influence), and formulation and implementation of an integrated management plan to secure its ecological character.

3.3 The Indian Wildlife (Protection) Act, 1972 is the crucial regulation protecting wildlife, including waterbirds. The Biological Diversity Act, 2002, and the rules thereunder empower the Central and State Governments to notify species which are on the verge of extinction or likely to become extinct in the near future as 'threatened species' and prohibit or regulate collection thereof for any purpose and take appropriate steps to rehabilitate and preserve those species.

3.4 The Ministry of Water Resources, River Development, and Ganga Rejuvenation Notification of October 7, 2016, namely the River Ganga (Rejuvenation, Protection and Management) Authorities Order, 2016 sets the overarching regulation and management framework for the Ganga River System, including tributaries, floodplains and connected surface and groundwater

regimes. Sahibi River, and its transformed Najafgarh Drain fall within the ambit of this regulatory framework. The order defines floodplains as 'areas of River Ganga or its tributaries which comes under water on either side of it due to floods corresponding to its greatest flow or with a flood of frequency once in hundred years', and thus encapsulate areas upto 213 m amsl (water level at Dhansa regulator in 1977 floods) surrounding the current wetland extent. Rule 4 (ix) provide that the entire floodplain zone to be construction free zone to reduce pollution sources, pressures and to maintain its natural ground water recharge functions. Unfortunately, construction permissions are being given on Haryana part, albeit with a caveat that the plinth levels of such construction be kept over the high flood level of the Najafgarh Jheel / drain attained in the last 100 years. There is no mechanism in place to ensure compliance is being done, especially when the 100 year flood zone is not properly demarcated, nor the boundaries of the wetland. Construction on the flood zone around Najafgarh Jheel should be completely prohibited on account of seismic and liquefaction risks.

3.5 India has launched a National Action Plan for Central Asian Flyway (CAF) in 2019. The Central Asian Flyway covers over 30 countries and has southward migration of birds in winter. India provides critical stopover sites to over 90% of the bird species known to use CAF migratory routes; including birds coming to India from Europe, central Asia, China, Tibet, and Russia. India's National Plan is the first updated Action Plan for the CAF, and provides a common strategic framework for regional collaboration and affirmative action for protecting, conserving, restoring, and sustainably managing populations of migratory bird species and their habitats in the Indian subcontinent falling under the Central Asian Flyway region. This National Action Plan is in line with the Convention on Migratory Species Strategic Plan for Migratory Species, 2015-2023.

3.6 India has shown its global leadership for conservation of wetlands and migratory birds by hosting the 13th Conference of Parties on the CMS in Gandhinagar, Gujarat. The meeting was in February 2020. At the meeting, India reaffirmed its commitments to conserve sites important for migratory animals and birds. At this meeting, the important decision of starting an institutional framework for the Central Asian Flyway in India was also taken.

Decision 13.46 of the CMS says:
Range States of the Central Asian Flyway (CAF) are requested to: a) collaborate with the Government of India and the Secretariats of CMS and AEWA during the inter-sessional period between the 13th meeting of the Conference of the Parties (COP13) and COP14 to further advance the process initiated in 2018 between the Government of India and both Secretariats; b) establish, by COP14, under the umbrella of CMS, an institutional framework, under the leadership of India and in consultation with the other range states and relevant stakeholders with the aim to agree on, inter alia, conservation priorities and related actions

3.7 There are a number of agencies which deal with different aspects of wetlands, or have bearing on the wetlands condition. A non-exhaustive listing is as follows:

a) Within the boundaries of Delhi NCT, maintenance of irrigation and drainage infrastructure linked with the Najafgarh Jheel are placed within the mandate of Irrigation and Flood Control Department (Civil Division I). The primary management purpose is achieving flood control.
b) The Development Department of Delhi Government issues licenses to fish in waters on payment of annual fee.
c) The Delhi Development Authority and Town and Country Planning Office, Government of Haryana provide the overarching master plan governing land use. Najafgarh Jheel and its surrounding areas are included within Zonal Plan L of Master Plan of Delhi, designated for maintenance of lake environments. This includes areas within the

revenue villages of Raota, Gumanhera, Jainpur, Shikarpur, & Jhatikara, extending to 356 Ha in Delhi. Similarly, the Gurgaon Master Plan shows the Jheel and its adjoining areas as open spaces.

d) The Delhi Jal Board and Gurgaon Municipal Corporation have the responsibility of managing the sewer network and drainage system, which ultimately drains into the wetland.

3.8 INTACH is a prominent civil society organization highlighting the importance of Najafgarh Jheel, seeking judicial intervention for wetland protection, and has also developed over a period of time, necessary information base for wetland rejuvenation. A network of bird watchers and enthusiasts under the aegis of Asian Waterbird Census Programme, Bombay Natural History Society and e-Bird Programme routinely conduct waterbird census. There are private land holdings in most part of the wetland (possibly excluding the area under permanent inundation), and the area inundated intermittently is cultivated.

3.9 It is to be noted that the National Green Tribunal, in an August 2020 order asked for status of significant wetlands and remedial action for the same for all states. The Court ordered that the same should be done within a period of three months. The order says:

"We also direct that the National Wetlands Committee may compile data of status of compliance of environmental norms in respect of all significant wetlands in the country to ensure remedial action. The State PCBs/PCCs and State/UT Wetland Authorities in India may give the status of management of wetlands in their respective States to the Secretary, MoEF&CC within three months."

3.10 Institutional arrangements for management of Najafgarh Jheel as an ecological entity are non-existent at present, and are a major deterrent to conservation of this wetland. In absence of specific arrangements, crucial activities like enforcement of regulation, wetlands monitoring, preventing fragmentation of hydrological regimes and preventing anthropogenic disturbance to waterbird habitats, especially herenories is not catered to.

3.11 To provide an enabling environment for integrated management of Najafgarh Jheel, it is recommended that a Najafgarh Jheel Wetlands Committee is constituted with following functions:

a) Overseeing compliance with extant regulations
b) Coordinating formulation of integrated management plan and implementation strategy
c) Establishing and maintaining an integrated wetland inventory, assessment and monitoring system
d) Reviewing development plans concerning the wetlands and its zone of influence, and making recommendations for preventing adverse ecological change
e) Communication and outreach on wetland values and functions
f) Promoting long term management-oriented multidisciplinary research to support wetland conservation and wise use

3.12 The committee may be jointly chaired by Member Secretaries of Wetlands Authorities of NCT Delhi and Haryana, and have representation from key line departments of the two states (irrigation and flood control, revenue, forests, agriculture, tourism, development, town and country planning, PHED, water utilities and others), MoEFCC representative, key CSOs, community representatives and individual experts. The Committee may function under MoEFCC or the National Capital Region Planning Board.

4. Management framework

4.1 Wetlands are managed to achieve their wise use. Article 3.1 of the Ramsar Convention, to which India is a signatory, commits the Contracting Parties to put in place management arrangements to ensure wise use of all wetlands within their jurisdiction. The text of the Ramsar Convention defines wise use as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development". Wise use is the longest established example amongst intergovernmental processes, implementation of which have become known as ecosystem approaches for conservation and sustainable development of natural resources, including wetlands. The approach recognizes the human interdependency with wetland functioning and accommodates sustainable utilization of these ecosystems for the benefit of humankind in a way compatible with the maintenance of natural properties of the ecosystem. Wise use encourages stakeholder engagement and transparency in negotiating trade-offs and determining equitable outcomes for wetland conservation while promoting maintenance of environmental, economic and social sustainability. The purpose of management planning is to outline the pathway through which wetland wise use can be achieved.

4.2 The term wise use is often interpreted to indicate that human use of all wetlands is promoted by the Ramsar Convention; however, this needs careful consideration. The most recent update of the wise use definition was in 2005, wherein along with the definition cited in the previous paragraph, two footnotes were also placed. The first clarifies that 'ecosystem approaches' include the elements elaborated by the Convention on Biological Diversity – integrated management, stakeholders' participation in decision-making, transparency about tradeoffs, and equitability of the outcomes. The second footnote expands the phrase 'in the context of sustainable development' to recognize that development, though inevitable in most cases, is not an objective for every wetland. Wherever development is to take place, it has to be facilitated in sustainable ways by approaches elaborated in the Convention. Thus, when the concept of wise use is examined from the lens of sustainability, the elements of wetlands' conservation' and 'use' are reconciled to ensure that ecosystem retains capability for use now and into future, rather than 'using' or developing the wetlands at present. The onus of elaborating a pathway for achieving wise use outcome is on the management planning process.

4.3 The Ramsar Convention, in its Resolution XI.11 of 2012 has laid down principles for planning and management of urban and peri-urban wetlands. The resolution recommends that:

a) thematic planning should be used as an essential tool to safeguard wetlands and their ecosystem services both within and beyond urban settlements;
b) the consideration of wetlands within urban planning needs to be integrated fully with wider elements of spatial planning (such as Integrated River Basin Management, water resource management, the development of transport infrastructure, agriculture production, fuel supply, etc.), and
c) alternative locations need to be identified for planned urban developments (both formal and informal built development) which do not lead to wetlands, or other natural ecosystems, being degraded or lost.

It is suggested that environmental appraisal committees at government level should invariably involve wetland experts to gather valid opinion about the area before the site is granted clearance for developmental projects.

4.4 Management of Najafgarh Jheel needs to be on the basis of recognition of the full range of ecosystem services and biodiversity values of the wetland and their mainstreaming into developmental planning at all levels. The effectiveness of management will be reflected in the

ability to sustain multiple use of the wetland, without undermining the key ecological and social processes that underpin the functioning of Najafgarh Jheel social-ecological system. Wise use of Najafgarh Jheel will be realized when the capability of the wetland to provide its ecosystem services and sustain rich biota is maintained now as well as in future, on pathways that are aligned with ecosystem principles and guided by sustainable development. Sustainable development framework, as adopted in 2015, call for addressing five elements – People, Partnership, Planet, Peace and Prosperity.

4.5 As the impacts of climate change unfold over the urban environs of NCT of Delhi and Haryana, extreme rainfall events and increase in temperatures are highly likely to become more frequent. The ability of Najafgarh Jheel to buffer extreme events, regulate local hydrology, as well as prevent release of harmful GHGs indicate the relevance of these wetlands in mitigation as well as adapting to climate change. At the same time, climate change and the ongoing developmental pressures, particularly rapid urbanization may lead to intensification of exiting risks as well as creating new risks of the ecosystem, thereby calling for systematic monitoring, and periodic adaptation in management approaches on the basis of new information that is generated in the process.

Goal and purpose

4.6 The goal of management is to '*maintain Najafgarh Jheel in a healthy condition to enable delivery of its full range of ecosystem services and sustain biological diversity values'*.

4.7 The purpose of management is to *'enable natural infrastructure services to the urban environs of NCT of Delhi and Haryana in the form of flood buffering, groundwater recharge and climate regulation; providing recreational and nature education opportunities; and sustain diversity of biota in the landscape'*.

Management Strategy

Management zoning for multiple use

4.8 The ability of Najafgarh Jheel to provide the diverse ecosystem services while also harbouring diverse biota is linked with multiple use the wetland is put to. The balance of land use between wetland environs and non-aquatic usages (agriculture and settlements) is key to ecosystem functioning. The land use regulation provided within the L-Zone of Master Plan of NCT of Delhi and Gurgaon, when supplemented with demarcation of wetland and its zone of influence as recommended under Wetlands (Conservation and Management) Rules, 2017 provide the regulatory architecture under which management zoning of Najafgarh Jheel can be framed for meeting conservation, development and regulation related outcomes.

Building with Nature

4.9 Building with Nature (BwN) is a comprehensive engineering approach that seeks to enhance the use of natural ecological processes to achieve efficient and sustainable infrastructural designs to provide a set of desired benefits. The BwN concept for Najafgarh is motivated and supported by nature that may also offer environmental, economic, and social benefits, while increasing resiliency.

4.10 Najafgarh Jheel offers wide range of natural infrastructure that have multiple functionalities like that of a flood buffer, water treatment plant, flood buffer, carbon sink, sediment trap, temperature regulators, and serving as biodiversity hotspot. By recognizing Jheel as an integral part of urban environs of Gurgaon and NCT of Delhi, and ensuring that land use planning protects ecosystem functioning, rather than creating adverse ecological impacts, the natural

infrastructure can be blended with existing urban infrastructure towards sustainable urban development.

Adaptive management

4.11 Najafgarh Jheel, as several other wetland ecosystems, have an inherent uncertainty and unpredictability in their behaviour owing to complex and multi-scalar ecological, social and institutional interactions that shape their features and governing factors. There are a number of reasons, including:

- Environmental variation that is uncontrollable (such as increasing intensity of precipitation)
- Partial observability (as not all wetland features and factors can be monitored)
- Partial controllability of actions (as management interventions are implemented through a number of agencies)
- Structural uncertainty arising out of lack of complete understanding of how the ecosystem functions

4.12 Given that the knowledge on ecosystem is always likely to be incomplete, an adaptive management based on iterative learning, and using that learning to improve management using a goal-oriented and structured process shall be applied. Adaptive management will be enabled in management of Najafgarh Jheel by a combination of processes, such as:

- Structured decision making to clarify management goals, objectives and actions, involving stakeholders
- Investing into monitoring and learning for management. Each management intervention in reality is an experiment based on a working hypothesis of ecosystem functioning. Monitoring enables assessment whether the hypothesis works in reality (for example, whether changing sewage composition is leading to epidemiological concerns for the wetlands communities)
- Investing into cross-scale communication. Understanding change at multiple scales (such as City Environments) may help getter a better understanding of ecosystem functioning and variability.
- Adaptive governance, based on collaborative and participatory management which has the flexibility of sharing management responsibilities. Successful adaptive governance has required leadership with a vision, systematic monitoring, complementary legislation framework which allows for adaptive management, information flow amongst stakeholders, and clear opportunities for stakeholders to collaborate.

Multiple values of nature and nature's contribution of people

4.13 Management plan implementation will take into account the diverse ways in which nature and nature's contribution to people support well-being. These will include intrinsic values (the value of Najafgarh Jheel as an ecosystem with its complex ecological functions), instrumental values (the value of Najafgarh towards meeting flood buffering, groundwater recharge, water quality regulation and climate moderation), and relational values (the values linked with sense of place and cultural identity). The management plan will be built on the full range of values to bring in multiple perspectives in in decision-making and implementation of programmes.

Focus on behaviour change

4.14 The management plan entails a complementing wetland regulation with inducing positive behaviour within stakeholders which are aligned with wise use. The Wetland Authorities of NCT of Delhi and Haryana will use strategic communication to inform stakeholders on the role of Najafgarh Jheel in their overall well-being, and the ways these groups can engage in ensuring that the wetland continues to deliver their wide-ranging services. Information, education and communication tools, tailor-made to the needs of various stakeholder groups, would be proactively used to trigger behaviour change, along with building capacities and opportunities for participation in wetlands management.

Objectives and performance indicators

4.15 The management strategies have been translated into eight objectives which reflect the desired state of key features of wetlands. For each feature, the performance indicators are the attributes which can indicate change. The desired outcome reflects the target which the management plan envisages to achieve within five years, thus providing a monitoring framework to assess effectiveness.

Table 3. Management objectives, performance indicators and targets

Objectives	Performance Indicators	Desired outcome
Objective 1. Land use and land cover of the wetland is maintained in line with regulatory requirements under Wetlands (Conservation and Management) Rules, 2017 and in concordance with Master Plans of NCT of Delhi and Gurgaon.	Land use and land cover change in comparison with the 2000 baseline Number of violations of the Wetlands (Conservation and Management) Rules, 2017	No illegal transformation of land use No violations of regulatory regime No building activity in hazard zone [i.e zone of influence or the flood zone and soil liquefaction zone]
Objective 2. Sewage received within the wetland is efficiently treated.	Quality of sewage	Sewage received in the wetland meets quality criteria for maintaining aquatic life (for example, DO is between 3 – 6 mg/ liter) Only tertiary class treated wastewater to enter Jheel in line with Court directives
Objective 3. Diversity of biota within Najafgarh Jheel is maintained.	Species richness Population of migratory waterbirds	No species extirpation Counts are maintained in the range of 20% deviation from average of last five years
Objective 4. Individual and collective capacity and opportunities for stakeholders and to participate in wetland management and contribute to wetland wise use is enhanced.	Participation of wetland communities in management plan implementation Evidences of affirmative behaviour change within communities	Integration of community, rights and capacities in management plan implementation and monitoring Local action for addressing solid waste or preventing encroachment

	living around Najafgarh Jheel supporting wise use of wetlands Evidences of community-led collaborative action for wise use of wetlands	Community norms for preventing land use change or overharvesting of resources
Objective 5. Systematic wetlands inventory, assessment and monitoring system is used to inform management decisions and assess effectiveness.	Availability of time-series data on wetland ecological character Availability of data on threats leading to adverse change in ecological character. Evidences of use of data generated from wetlands inventory, assessment and monitoring system in decision-making.	Data is available on all priority wetland features Data in available on threats Data is systematically analysed and presented in meetings of Wetlands Authorities of Haryana and NCT of Delhi .
Objective 6. Integration of multiple values of wetlands in sectoral developmental planning is enhanced.	Number of sectoral policies (wherein integration of wetlands is relevant) which take into account wetlands values.	Najafgarh Wetlands Committee meets regularly and considers implications of sectoral plans. Najafgarh Wetlands Committee enables integration of role of wetlands in programmes and actions plans on urban development, linear infrastructure development, disaster risk reduction, climate change adaptation and others.
Objective 7. Restoration of wetland habitat and removal of invasive species	Increase in native biota and species diversity	A time-bound plan to remove invasive species and ecological restore the habitat is followed, invasive species are removed or managed.

Management Components and Actions

Component 1. Institutional arrangements

1.1 Notification under Wetlands (Conservation and Management) Rules, 2017

For the purpose of regulation under the provisions of Wetlands (Conservation and Management) Rules, 2017, the area falling under contour 209.5 m amsl, on the either side of the Najafgarh embankment is demarcated as a wetland. The area between 209.5 m amsl and 211 m amsl may be designated as the 'zone of influence' wherein developmental activities are to be regulated to ensure that ecological character of wetland is maintained, and not adversely affected. A regulatory framework indicating activities prohibited, regulated and permitted within the wetland and its zone of influence is outlined in Table 4, and can serve as the basis of issuing the draft notification under Wetlands (Conservation and Management) Rules, 2017. It is understood that as per the procedure recommended under the Guidelines for Implementation of Wetlands (Conservation and Management) Rules, 2017, the draft notification will be issued by the Ministry of Environment, Forest and Climate Change, based on the brief documents submitted by the Wetlands Authorities of NCT of Delhi and Haryana.

Table 4. Regulatory framework for Najafgarh Jheel

	Within wetland	Within zone of influence
Prohibited activities	• Conversion for non-wetland uses including encroachment of any kind; • Setting up of any industry and expansion of existing industries; • Manufacture or handling or storage or disposal of construction and demolition waste; hazardous substances or the Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms Genetically engineered organisms or cells,; electronic waste covered under the E-Waste (Management) Rules, 2016; • Solid waste dumping; • Discharge of untreated wastes and effluents from industries, cities, towns, villages and other human settlements; • Any construction of a permanent nature except for boat jetties within fifty metres from the mean high flood level observed in the past ten years calculated from the date of commencement of these rules; • Construction of new roads and widening of existing ones not allowed, and, • Poaching.	• Regulation of inflowing water sources • Alteration of land use. • Poaching.

Regulated activities	• Subsistence level biomass harvesting (including traditional practices); • Sustainable culture fisheries practices (in private lands); • Plying of non-motorized boats; • Desilting of silted up channels ; • Construction of temporary nature • Vehicular traffic on the ebbankment – especially during bird migration seasons	• Groundwater development • Construction of new roads and widening of existing ones • Sustainable culture fisheries practices (in private lands)
Permitted activities	• Ecological rehabilitation and rewilding of nature ; • Wetlands inventory, assessment and monitoring; • Research; • Communication, environmental education and participation activities; • Management planning; • Habitat management and conservation of wetland-dependent species; • Community-based ecotourism (with minimum construction activities).	

1.2 Wetland demarcation

It is recommended that the wetland boundaries in NCT Delhi and Haryana are marked on ground with geo-tagged boundary pillars. The pillars may be placed at an interval of 200 meters.

1.3 Constitution of Najafgarh Wetlands Committee

Najafgarh Jheel Wetlands Committee may be constituted with following functions:

a) Overseeing compliance with extant regulations
b) Coordinating formulation of integrated management plan and implementation strategy
c) Establishing and maintaining an integrated wetland inventory, assessment and monitoring system
d) Reviewing development plans concerning the wetlands and its zone of influence, and making recommendations for preventing adverse ecological change
e) Communication and outreach on wetland values and functions
f) Promoting long term management-oriented multidisciplinary research to support wetland conservation and wise use
g) Habitat restoration for enhanced ecological function

The committee may be jointly chaired by Member Secretaries of Wetlands Authorities of NCT Delhi and Haryana, and have representation from key line departments of the two states (irrigation and flood control, revenue, forests, agriculture, tourism, development, town and country planning, PHED, water utilities and others), MoEFCC representative, key CSOs, community representatives and individual experts.

1.4 Wetland inventory, assessment and monitoring system

Developing a monitoring plan for Najafgarh Jheel requires addressing the following inter-related requirements of wetland inventory and wetland assessment. It is imperative therefore to put in place an integrated Wetland Inventory, Assessment and Monitoring System (WIAMS) to address the overall information needs for wetland management, and to provide a robust decision support system for the same. The ambit of monitoring is also envisaged to include assessment of management effectiveness. The follow are the specific objectives for establishing WIAMS:

- Developing up-to-date and scientifically valid information on status and trends of wetland features and influencing factors
- Establishing a baseline for measuring change in ecosystem components, processes and services
- Informing decision makers and stakeholders on the status and trends in biodiversity, ecological functioning and ecosystem services of the wetland
- Supporting compliance to national and state legal requirements and regulatory regimes
- Determining impacts of developmental projects on ecosystem components, processes and services
- Identifying risks to ecological character and support development of response strategies
- Assessing effectiveness of wetland management

1.4.1 Establishment of wetland monitoring and research centre

A wetland monitoring center is proposed to be set up as part of the Najafgarh Jheel interpretation center to function as a nodal unit for all monitoring, education and research actions.

1.4.2 Development of database management system

A database system for storing, retrieving and analysing the WIAMS is proposed to be set up in a GIS environment. This will include:

- development of data quality management and assurance plan including specification of data collection objectives, data quality objectives, sampling programme design, data and metadata documentation procedure, data quality control methods and performance audit procedures;

- development of GIS based database management system

1.5 Ecosystem Health Report Card

It is proposed to develop an Ecosystem Health Report Card, and publish biannually to assess and communicate wetland monitoring information to decision-makers and stakeholders. The health report card summarizes indicators along major indices (water quality, catchment status, biodiversity status) which represent various ecosystem features of the lake, and are reported against respective thresholds set in line with management goals.

Component 2. Water management

2.1 Construction of regulator at Jhatikra

A regulator is proposed to be constructed at Jhatikra to allow for maintenance of inundation regime of the wetland to meet diverse ecological needs (for example, diversity of habitats for waterbirds) and human needs (such as flood control and availability of water for domestic use).

2.2 Sediment removal

The natural flow gradient of the inflowing drainages may be desilted to achieve the desired inundation levels in the wetland as well as prevent waterlogging in the upstream stretches. Highly silted up areas of the wetland may be selectively desilted, however, due caution must be given to the species habitats, and management of dredged material.

2.3 Restoring flood pulses and hydrological connectivity

Sluices may be constructed on the embankment on Delhi side (between Shikarpur and Jhiljhili villages) to allow for spreading peak monsoon flow pulses and groundwater recharge.

Flow obstructions, such as power sub-station may be relocated.

The road on the embankment may not be further developed, and alternate connectivity provided. Vehicular traffic on the road also needs to be regulated, especially during peak migration season of waterbirds.

2.4 Pollution abatement

In-situ treatment of major inflowing drains into the wetland through use of appropriate technologies, including constructed wetlands should be ensured. The treated inflows should atleast meet the standards for sustaining aquatic life. Industrial effluents from drain flowing from Manesar should be appropriately treated before being released into Najafgarh Jheel.

Haryana Authorities may ensure the sewage discharged into the wetland is treated to tertiary level. in compliance with various judicial directives.

Component 3. Biodiversity conservation

3.1 Species inventory

A comprehensive species inventory (animal and plants) for the wetland and its adjoining habitats should be made. For key species such as waterbirds, fish and butterflies, their habitat preferences should be determined and wetland management must strive to maintain these conditions.

3.2 Protection of heronries

Najafgarh wetland is an important heronry for North India and particularly for NCR. There are large trees in several parts of the wetland. These include trees growing on the boundaries of the wetland on the Bund road, and trees growing in portion of the Jheel which forms a 'double channel' (some of these trees are indicated as heronries on the map). Trees along the Dhansa regulator are also heronries. It is important that these trees be protected. Where birds are actively breeding, the impenetrable nature of shrubbery and ground vegetation should be maintained. This reduces disturbance to breeding birds and hatchlings.

3.3 Managing water levels for diverse species

Najafgarh wetland has varying depths and forms suitable habitat for various kinds of wading and diving birds. Greater Flamingos require shallow water, and presently move in shallow areas of the jheel (often observed close to Bahadurshah drain, this has been marked on the map). Other birds

found in shallow water such as Black-winged stilts, Red-wattled lapwings, migratory White-tailed lapwing, Grey-headed Swamphen, Moorhens, Greenshanks and Sandpipers are found in shallower parts of the wetland. Ducks, Pochards and migratory Bar-headed Geese are found in deeper parts of the water.

It is also imperative the shores of the wetland should not be made into hard edges by civil works. The transition zone of mud/marsh into the water is an important foraging area for migratory and resident birds. From an ecological perspective, these 'banks' require protection.

3.4 Management of invasive species

Continuous discharge of sewage and untreated effluents and fragmented hydrological regimes have created conducive conditions for proliferation of invasive species, particularly water hyacinth in most parts of the wetland. Its rapid spread can create several adverse implications for key wetland processes, such as availability of light and oxygen for aquatic life, siltation and diminution of open water habitats. Comprehensive removal of water hyacinth is neither feasible, nor desired in absence of insufficient wastewater treatment capacity.

Hyacinth needs management from both Delhi and Haryana side. This will include manual removal, as well as reducing sewage runoff into the waters. Enterprise for economic utilization of water hyacinth, such as production of handicrafts, can be set up after due feasibility assessment.

Several *Prosopis Juliflora* trees are seen at the site. However, some of these trees are being used in the heronries as breeding sites by birds. The mature trees should not be disturbed. Instead, the site should be periodically checked to prevent the regeneration of new *Prosopis Juliflora* trees and saplings.

Several phragmites reeds are seen in the wetland. Such reeds and grasses are habitat for birds such as herons, bitterns and moorhens. These should not be cleared in the name of 'beautification'.

3.5 Management of agricultural land around the wetland

Cultivated land around the wetland are foraging areas for Sarus Crane, Greater Flamingos, land birds and migratory birds. The threatened Sarus Crane and the Common Crane both use submerged lands for foraging. Migratory birds coming from Central Asia, like Siberian stonechats, use the dry farmlands. For the sake of environment and human health as a whole, least amounts of pesticide and fertilisers should be used in agriculture around the wetland. This will also reduce chemical runoff to the wetland. The farmers around the Najafgarh jheel should be incentivised to embrace organic agriculture.

Picture 8: Greater Flamingos and Spoonbills recorded on Expert Committee site visit on 11 November 2020. Greater Flamingos forage in Najafgarh jheel and surrounding farmlands. Photo by Neha Sinha

3.5 Waterbird Census

Regular monitoring of waterbird population following standard protocols as the Asian Waterbird Census at all the major congregation sites within and around Najafgarh Jheel shall be maintained in a coordinated manner so as to understand comprehensively the significance of the wetlands for waterbirds (both resident and migratory) and to plan and monitor habitat management strategies and actions.

The management plan will support mid-winter counts of waterbird as per Asian Waterbird Census protocol. The census may be carried out in collaboration with BNHS and Wetlands International South Asia, with prior experience in conducting such census. Census programmes will include training of prospective census participants and local waterbird enthusiasts.

Data collected during this monitoring work will include collection of detailed information on habitat structure and seasonal abundance and changes in different prey items (aquatic flora and fauna). Information collected should enable realistic population estimates of the different waterbirds and trends to be developed and provide guidance for management activities.

Component 4. Communication, Education and Capacity Development

4.1 Interpretation center

A wetland interpretation center should be constructed (Haritima is a possible location) to educate visitors on the diverse values and functions of the wetland, and create the basis of an affirmative behaviour for conservation of wetlands. The center should have facilities such as audio visuals, interactive displays, meeting and workshop space, viewing galleries and other facilities to provide complete visitor experience.

4.2 Signage

Signage at entry and exit locations, and at key vantage points around the wetland may be placed to communicate the value of Najafgarh Jheel, management arrangements, and dos and donts for people which in wetland.

4.3 Environmental education and awareness generation programmes

The interpretation center can be used as node for environment education and awareness generation programmes for diverse stakeholder groups on the values and functions of wetland, and the ways they can engage in conservation and wise use. These programme should be designed on the basis of needs assessment.

Component 5. Research and Capacity Development

5.1 Research Studies

Following specific research studies are proposed to be commissioned to address the knowledge gaps in supporting integrated management of Najafgarh Jheel:

- Water balance – to assess the contribution of various inflow sources, uptake within plants and other ecological processes, contribution to groundwater, and outflow.
- Bird ringing and banding – to understand bird habitat use and migration patterns.
- Carbon and GHG Flux assessment – to assess the role of Najafgarh Jheel in sequestering carbon and GHG, and this integrate role of these wetlands in climate change mitigation strategies
- Nutrient budget - to assess the quantity of nutrients entering Najafgarh Jheel, its uptake within wetland and discharge downstream
- Multiple values assessment – to assess multiple values communities living in and around Najafgarh Jheel associate with the wetland, the underlying reasons and the ways in which this value can be orientated towards behaviour change for wetland wise use

5.2 Capacity development

To support integrated management of Najafgarh Jheel, the human capacity of concerned line departments as well as stakeholders may be enhanced by training workshops on:

- Integrated wetlands management

- Wetlands inventory assessment and monitoring
- Land use planning for multiple wetlands use
- Wetlands and climate change mitigation and adaptation
- Integrating wetlands wise use in developmental planning

Monitoring and Evaluation Mechanisms

Monitoring strategy responds to the following information needs for managing Najafgarh Jheel:

- inventory - to establish the ecological character baseline
- assessment – to establish status, trends and threats to wetland using inventory information
- monitoring – to assess changes in status and trends, including reduction in existing threats or appearance of new threats, or even changes in management effectiveness

As this information pertain to various spatial scales, the overall information requirements can be classified into three hierarchical levels:

- the Najafgarh Jheel
- the zone of influence of Najafgarh Jheel
- Sahibi Basin

This monitoring information adequately addresses the needs of East Kolkata Wetlands (Conservation and Management) Act, 2006 and Wetland (Conservation and Management) Rules, 2017 of the Ministry of Environment, Forests and Climate Change. A list of wetland features, indicators and corresponding methodology and data collection frequency is provided as Annex 2. The monitoring and assessment needs are envisaged to be addressed by a dedicated monitoring programme and specific research and assessment projects. Inventory, being based on collated information on identified wetland features and management practices, will be developed based on the monitoring and assessment information, as well as secondary sources.

Linkages also need to be developed so that data from the existing monitoring networks of different agencies (for example, inundation and flooding information from Central Water Commission and Department of Water Resources; groundwater quality and quantity from Central Ground Water Board; select surface water quality parameters from Central Pollution Control Board; and fish production from Fisheries Department) can be accessed and shared. Similarly, provision for participation of NGOs and civil society in monitoring programme has also been built, especially for socioeconomics and livelihoods aspects and biodiversity monitoring (for example, waterbird census being implemented by NGOs under the aegis of Asian Waterbird Census).

Table 5. Inventory, assessment and monitoring needs for managing Najafgarh Jheel

	Information Purpose		
Information Scale	**Inventory**	**Assessment**	**Monitoring**
Najafgarh Jheel	**Physical setting** (area, boundary, connectivity) **Water regime** (sewage flows, inflow -outflow balance, surface-groundwater interactions,	**Water quality improvement** (extent of reduction in BOD, COD, nutrients and heavy metals)	**Land use and Land cover change** in Najafgarh Jheel **Sewage quality** (presence of heavy metals and toxic chemicals)

	inundation regimes, quality, regulation) **Sewage quantity and quality** **Biota** (plant and animal species)	**Carbon sequestration** (carbon stored in various forms) **Trends in invasive species**	
Zone of influence	**Physical extent** (area, depth) **Groundwater** (level, abstraction and quality) **Biota** (plant and animal species) **Sectoral programmes and institutional arrangements** for management of land and water resources and biodiversity conservation	**Ecological character change** (change in ecosystem components, processes and services – can also be derived based on assessment of indicators related to ecosystems, habitat, species and / or management) **Soil quality trends** **Inundation trends** **Groundwater level and quality trends** **Trends in herenories** (species, nests)	**Land use and Land cover change** (with respect to 2000 baseline)
Sahibi River	**Geology and Geomorphology** (Soils, elevation, slope, drainage pattern) **Climate** (Precipitation, Temperature) **Land use and land cover**	**Climate risk and vulnerability** (changes in runoff and implications for Najafgarh Jheel)	**Urban planning** (water regulating structures and water allocation, sewage treatment infrastructure development, expansion of settlements) and implications for Najafgarh Jheel

	Water regimes (river flows, runoff, upstream abstraction)		

5. Budget and financing

The budget may be firmed up in consultation with Wetlands Authorities of NCT of Delhi and Haryana. The MoEFCC guidelines recommend financing based on convergence basis – wherein the activities identified in management plan are assessed for complementarity with existing central or state government funded programmes, and synergies developed.

Annexes

A1. Committee Constitution and Terms of Reference

OFFICE OF THE WETLAND AUTHORITY
DEPARTMENT OF ENVIRONMENT, GOVT. OF N.C.T. OF DELHI
"C" Wing, 6th Level, Delhi Secretariat, I.P. Estate, New Delhi – 110002
Tele-Fax : 011-23392736, Email : ccodpgsenv.delhi@nic.in
Website: http://dpgs.delhigovt.nic.in

No. F.1(15)/DPGS/CC/2018-19/828 – 836 Dated: 29/10/2020

ORDER

I. Conservation of Najafgarh Jheel is subject of Hon'ble NGT OA No. 153/2014, Indian National Trust for Art & Cultural Heritage Vs. Govt. of NCT of Delhi & Ors. and to aid preparation of Environment Management Plan of the Jheel, an Expert Committee is formed of the following members:-

1.	Sh. Ishwar Singh, Principal Chief Conservator of Forests, GNCTD	Chairperson
2.	Dr. C.R. Babu, Professor Emeritus, Centre for Environmental Management of Degraded Ecosystems (CEMDE)	Member
3.	Sh. Manu Bhatnagar, Director, Indian National Trust for Art and Culture Heritage (INTACH)	Member
4.	Dr. Ritesh Kumar, Director, Wetlands International South Asia (WISA)	Member
5.	Ms. Neha Sinha, Advocacy Officer, Bombay Natural History Society (BNHS, India)	Member

II. The terms of reference of the above Expert Committee will be:-

1. To recommend contour level, delineated maps of Najafgarh Jheel and its zone of influence and the total area of Najafgarh Jheel which needs to be notified under Wetlands (Conservation and Management) Rules, 2017.

2. To recommend an Environment Management Plan of Najafgarh Jheel which will also include prohibited and regulated activities.

III. The following members would assist the Expert Committee through field information, data and maps required for the exercise:-

1.	Representative of District Magistrate (South West), GNCTD
2.	Representative of I&FC Department, GNCTD
3.	Representative of GSDL, GNCTD
4.	Representative of Wetland Authority of Delhi, GNCTD

The Committee is requested to submit its recommendations before 30th November' 2020.

This issues with the approval of Hon'ble Minister, Environment and Forest.

(Sanjeev Khirwar)
Principal Secretary
(Environment, Forests & Wildlife)

Dated: 29.10.2020

To,
1. Sh. Ishwar Singh, Principal Chief Conservator of Forests, GNCTD
2. Dr. C.R. Babu, Professor Emeritus, Centre for Environmental Management of Degraded Ecosystems (CEMDE)
3. Sh. Manu Bhatnagar, Director, Indian National Trust for Art and Culture Heritage (INTACH)
4. Dr. Ritesh Kumar, Director, Wetlands International South Asia (WISA)
5. Ms. Neha Sinha, Advocacy Officer, Bombay Natural History Society (BNHS, India)
6. Distt. Magistrate (South West), GNCTD
7. Chief Engineer (I&FC), GNCTD
8. MD, GSDL, GNTCD
9. Member Secretary (Wetland Authority of Delhi)

A2. List of birds recorded at Najafgarh Jheel

This bird list has been contributed to by a range of citizen scientists and birdwatchers, and has been peer-reviewed. A portion of it is available on ebird.org

281 Bird species

Waterbirds

Lesser Whistling-Duck
Bar-headed Goose
Graylag Goose
Greater White-fronted Goose
Knob-billed Duck
Ruddy Shelduck
Common Shelduck
Cotton Pygmy-Goose
Garganey
Northern Shoveler
Gadwall
Eurasian Wigeon
Indian Spot-billed Duck
Mallard
Northern Pintail
Green-winged Teal
Garganey/Green-winged Teal
teal sp.
Red-crested Pochard
Common Pochard
Ferruginous Duck
Tufted Duck
Aythya sp.
duck sp.
waterfowl sp.

Grouse, Quail, and Allies

Indian Peafowl
Rain Quail
Black Francolin

Gray Francolin
francolin sp.

Flamingos

Greater Flamingo
flamingo sp.

Grebes

Little Grebe
Great Crested Grebe
grebe sp.

Pigeons and Doves

Rock Pigeon
Oriental Turtle-Dove
Eurasian Collared-Dove
Red Collared-Dove
Spotted Dove
Laughing Dove
Yellow-footed Green-Pigeon
pigeon/dove sp.

Sandgrouse

Pin-tailed Sandgrouse (Historic record from 1874 by F.R.Blewitt)
Chestnut-bellied Sandgrouse

Cuckoos

Greater Coucal
Pied Cuckoo
Asian Koel
Grey-bellied Cuckoo
Cacomantis sp.
Common Hawk-Cuckoo
Common Cuckoo

Swifts

Little Swift
swift sp.

Rails, Gallinules, and Allies

Water Rail
Eurasian Moorhen
Eurasian Coot
Gray-headed Swamphen
moorhen/coot/gallinule sp.
Watercock
White-breasted Waterhen
Ruddy-breasted Crake
Brown Crake
Baillon's Crake

Cranes

Demoiselle Crane
Sarus Crane
Common Crane

Shorebirds

Indian Thick-knee
Black-winged Stilt
Pied Avocet
Pacific Golden-Plover
Northern Lapwing
River Lapwing

Yellow-wattled Lapwing
Gray-headed Lapwing
Red-wattled Lapwing
White-tailed Lapwing
Lesser Sand-Plover

Kentish Plover
Little Ringed Plover
Greater Painted-Snipe
Pheasant-tailed Jacana
Bronze-winged Jacana
Whimbrel
Eurasian Curlew
Black-tailed Godwit
Ruff
Sharp-tailed Sandpiper (spotted after 137 years by Rohit Kumar)
Curlew Sandpiper
Temminck's Stint
Dunlin
Little Stint
peep sp.
Jack Snipe
Common Snipe
Common Sandpiper
Green Sandpiper
Spotted Redshank
Common Greenshank
Marsh Sandpiper
Wood Sandpiper
Common Redshank
Tringa sp.
Barred Buttonquail
buttonquail sp.
Oriental Pratincole
Small Pratincole
pratincole sp.

shorebird sp.

Gulls, Terns, and Skimmers

Black-headed Gull
Brown-headed Gull
Black-headed/Brown-headed Gull
Pallas's Gull
gull sp.
Little Tern
Gull-billed Tern
Whiskered Tern
River Tern
tern sp.

Storks

Asian Openbill
Woolly-necked Stork
Black-necked Stork
Painted Stork

Cormorants and Anhingas

Oriental Darter
Little Cormorant
Great Cormorant
Indian Cormorant
Little/Indian Cormorant
cormorant sp.

Pelicans

Great White Pelican

Herons, Ibis, and Allies

Great Bittern
Yellow Bittern
Cinnamon Bittern
Black Bittern
Gray Heron
Purple Heron
Great Egret
Intermediate Egret
Little Egret
Cattle Egret
white egret sp.
Indian Pond-Heron
Striated Heron
Black-crowned Night-Heron
heron sp.
Glossy Ibis
Black-headed Ibis
Red-naped Ibis
ibis sp.
Eurasian Spoonbill

Vultures, Hawks, and Allies

Osprey
Black-winged Kite
Egyptian Vulture
Oriental Honey-buzzard
Crested Serpent-Eagle
Short-toed Snake-Eagle
Indian Spotted Eagle
Greater Spotted Eagle
Booted Eagle
Steppe Eagle
Imperial Eagle
Bonelli's Eagle

Aquila sp.
White-eyed Buzzard
Eurasian Marsh-Harrier
Shikra
Accipiter sp.
Black Kite
Brahminy Kite
Common/Himalayan Buzzard

Long-legged Buzzard
Buteo/eagle sp.
eagle sp.

Owls

Barn Owl
Indian Scops-Owl
Spotted Owlet
Short-eared Owl
owl sp.

Hoopoes

Eurasian Hoopoe

Hornbills

Indian Gray Hornbill

Kingfishers

Common Kingfisher
White-throated Kingfisher
Pied Kingfisher

Bee-eaters, Rollers, and Allies

Green Bee-eater
Blue-cheeked Bee-eater
Blue-tailed Bee-eater
bee-eater sp.
European Roller

Indian Roller

Barbets and Toucans

Coppersmith Barbet
Brown-headed Barbet
Psilopogon sp.

Woodpeckers

Eurasian Wryneck
Yellow Crowned Woodpecker
Black-rumped Flameback

Falcons and Caracaras

Eurasian Kestrel
Red-necked Falcon
Eurasian Hobby
Peregrine Falcon

Parrots, Parakeets, and Allies

Alexandrine Parakeet
Rose-ringed Parakeet
Plum-headed Parakeet
parakeet sp.

Cuckooshrikes

Long-tailed Minivet

Old World Orioles

Indian Golden Oriole

Vangas, Helmetshrikes, and Allies

Common Woodshrike

Fantails

White-browed Fantail

Drongos

Black Drongo
Ashy Drongo
White-bellied Drongo
drongo sp.

Monarch Flycatchers

Indian Paradise-Flycatcher

Shrikes

Isabelline Shrike
Brown Shrike
Red-tailed/Isabelline/Brown Shrike
Bay-backed Shrike
Long-tailed Shrike
Great Gray Shrike
Iberian Gray/Great Gray Shrike
shrike sp.

Jays, Magpies, Crows, and Ravens

Rufous Treepie
House Crow
Large-billed Crow

Fairy Flycatchers

Gray-headed Canary-Flycatcher

Larks

Ashy-crowned Sparrow-Lark
Bengal Bushlark
Indian Bushlark
Singing/Indian Bushlark
Greater Short-toed Lark
Greater/Sykes's Short-toed Lark
Greater Short-toed/Hume's Lark
Oriental Skylark
Crested Lark
lark sp.

Cisticolas and Allies

Common Tailorbird
Gray-breasted Prinia
Graceful Prinia
Jungle Prinia
Yellow-bellied Prinia
Ashy Prinia
Plain Prinia
prinia sp.
Zitting Cisticola

Reed Warblers and Allies

Booted Warbler
Sykes's Warbler
Moustached Warbler
Paddyfield Warbler
Blyth's Reed Warbler
Clamorous Reed Warbler

Acrocephalus sp.

Grassbirds and Allies

Common Grasshopper-Warbler
Bristled Grassbird

Martins and Swallows

Gray-throated Martin
Bank Swallow
Dusky Crag-Martin
Barn Swallow
Wire-tailed Swallow
Red-rumped Swallow
Streak-throated Swallow
swallow sp.

Bulbuls

Red-vented Bulbul
Red-whiskered Bulbul
White-eared Bulbul

Leaf Warblers

Hume's Warbler
Sulphur-bellied Warbler
Common Chiffchaff
Greenish Warbler
Phylloscopus sp.

Sylviid Warblers

Lesser Whitethroat

Parrotbills, Wrentit, and Allies

Yellow-eyed Babbler

White-eyes, Yuhinas, and Allies

Indian White-eye

Laughingthrushes and Allies

Common Babbler
Striated Babbler
Large Gray Babbler
Jungle Babbler

Starlings and Mynas

European Starling
Rosy Starling
Asian Pied Starling
Brahminy Starling
Common Myna
Bank Myna

Thrushes

Black-throated Thrush

Old World Flycatchers

Indian Robin
Oriental Magpie-Robin
Verditer Flycatcher
Bluethroat
Taiga Flycatcher
Red-breasted Flycatcher
Ficedula sp.
Black Redstart
Blue Rock-Thrush
Siberian Stonechat
White-tailed Stonechat
Pied Bushchat
Isabelline Wheatear
Desert Wheatear
Brown Rock Chat
Variable Wheatear

Sunbirds and Spiderhunters

Purple Sunbird

Weavers and Allies

Streaked Weaver
Baya Weaver
Black-breasted Weaver
Ploceus sp.

Estrildids

Red Avadavat
Indian Silverbill
Scaly-breasted Munia
Tricolored Munia

Old World Sparrows

House Sparrow
Spanish Sparrow
Sind Sparrow
Passer sp.
Yellow-throated Sparrow

Wagtails and Pipits

Gray Wagtail
Western Yellow Wagtail
Citrine Wagtail
White-browed Wagtail
White Wagtail
wagtail sp.
Paddyfield Pipit
Long-billed Pipit
Tawny Pipit
Rosy Pipit
Tree Pipit
Olive-backed Pipit
Water Pipit
pipit sp.

Finches, Euphonias, and Allies

Common Rosefinch

Old World Buntings

Crested Bunting
Red-headed Bunting
White-capped Bunting

A3. List of Butterflies recorded at Najafgarh Jheel

LEPIDOPETRA PAPILIONOIDEA
Longer list is under preparation. A non-exhaustive list is below, as noted by Neha Sinha, BNHS

1. Common Grass Yellow
2. Mottled Emigrant
3. Lemon Pansy
4. Grey Pansy

A4. List of Dragonflies recorded at Najafgarh Jheel

ANISOPETRA

1. Vagrant Emperor
2. Trumpet tail
3. Scarlet Marsh Hawk
4. Ditch Jewel
5. Granite Ghost
6. Ruddy Marsh Skimmer
7. Black Ground Skimmer
8. Black Tipped Ground Skimmer
9. Pied Paddy Skimmer
10. Crimson Tailed Marsh Hawk
11. Wandering Glider
12. Common Picturewing
13. Long legged Marsh Glider

ZYGOPETRA

1. Pygmy Dartlet
2. Pixie Dartlet
3. Coromandel Marsh Dart
4. Golden Dartlet
5. Senegal Golden Dartlet
6. Three Striped Blue Dart

A5. Recommended monitoring parameters for Najafgarh Jheel

Parameter	Indicator	Priority	Monitoring Method	Monitoring Frequency
Land Use and Land Cover				
Land use and land cover change within Najafgarh Jheel and zone of influence	% area under various land use and cover classes (agriculture, , settlements, wetlands)	High	GIS and Remote Sensing Radar sensed data	Once every year
Compliance with Wetlands (Conservation and Management) Rules, 2017 and Master Plans for NCT of Delhi and Gurgaon.	Violations	High	Mobile based surveillance system operated by communities' wardens Drone mapping and other technologies for surveillance of land use change .	Daily One every six months
Hydrological Regimes				
Water flux	Sewage inflow	High	Monitoring stations at Dhansa and Jhatikra	Daily
	Sewage outflow	High		Daily
	Sediment inflow	High		Annual
	Sediment outflow	High		Annual
Water holding capacity	Bathymetry	High	Bathymetric surveys	Once in 5 years
Inundation Regime	Seasonal fluctuation in waterspread area	High	Remote sensing	Once in 5 years
Sewage quality	Temperature	Medium	Standard procedures of APHA	Monthly
	pH	High		Monthly
	Dissolved Oxygen	High		Monthly
	Specific Conductance	High		Monthly

	Nutrients and Nutrient Cycling (Nitrate, Phosphate, Silicate)	High		Monthly
	Cations and Anions (Calcium, Magnesium, Sulphate, Chloride, Fluoride, Sulphite)	High		Monthly
	Chemical Oxygen Demand	High		Monthly
	Heavy metals (Arsenic, Mercury, Cadmium, Chromium,Lead)	High		Monthly
	Biological oxygen demand	Medium	Standard procedures of APHA	Monthly
	Total Coliform	Medium		Annual
	Faecal coliform	Medium		Annual
Wetland soils	Texture	Low	Standard procedures of APHA	Annual
	pH	High		Annual
	Organic carbon	High		Annual
	Available nitrogen	High		Annual
	Available phosphorus	High		Annual
	Available calcium carbonate	Medium		Annual
	Heavy metals (Arsenic, Mercury, Cadmium, Chromium, Lead)	High		Annual
Ground water	Water level	High	Methodology approved by Groundwater Estimation Committee (1997)	Seasonal (Summer, Monsoon, Post-monsoon, Winter)
	Conductivity	Medium		Annual
	Total hardness	Medium		Annual
	Chloride	Medium		Annual
	Fluoride	High		Annual
	Arsenic	High		Annual
	Heavy metals	High		Annual

Water abstraction	Water abstracted for irrigation	Medium	Survey	Annual
	Water abstracted for domestic use	Medium		
Air quality	Suspended Particulate Matter (PM 2.5, PM 10)	High	Standard procedures laid by CPCB for air quality monitoring	Daily
	Temperature and Relative Humidity	High		
Ecosystem Processes and Biodiversity				
Flora	Phytoplankton (diversity and abundance)	Medium	Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal
	Periphyton	Medium		Seasonal
	Macrophytes (diversity and abundance	High		Seasonal
	Species invasion	High	Habitat Sampling and Remote sensing (using high resolution data)	Once in 2 years
	Primary production	High	Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal
	Zooplankton (diversity and abundance)	Medium	Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal
Fauna	Aquatic macro-invertebrates	Medium	Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal
	Aquatic Insects	Medium	Taxonomic studies, Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Seasonal
	Fish diversity	High	Taxonomic studies	Once in 5 years
	Amphibians	High	Taxonomic studies	Once in 5 years
	Reptiles	High	Taxonomic studies	Once in 5 years
	Fish catch and effort (number of harvest cycles, catch)	High	Standard procedures in Central Inland Fisheries Research Institute Bulletin No. 10	Monthly

	Water Bird population and diversity	High	Census and Taxonomic studies	Annual
	Avian disease	Medium	Surveillance	Annual