Memorandum

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Date: February 10, 2017

To: Merle Keefe, Sabina Gold & Silver Corp.

From: Kathryn Kuchapski, ERM (M.Sc., P. Biol.)

Cc: Deborah Muggli, ERM (Ph.D., R.P. Bio.); Geneviève Morinville, ERM (Ph.D.); Korina Houghton, ERM (B.Sc.)

Subject: **Rascal Stream Fish Passage Mitigation**

1. INTRODUCTION

1.1 Overview

The Sabina Gold & Silver Corp. (Sabina) Back River Project (the Project) is a proposed gold mine located in the West Kitikmeot region of Nunavut (Figure 1.1-1).

A Final Environmental Impact Statement (FEIS) for the Project was submitted to the Nunavut Impact Review Board (NIRB) in November of 2015 (Sabina 2015). The FEIS included an assessment of all phases of the proposed Project including ongoing Exploration, Mobilization and Construction, Operations, Closure and Post Closure.

During a technical comment phase following submission of the FEIS, Fisheries and Oceans Canada (DFO) commented on the assessment of impacts of the Project on the Arctic Grayling population of Goose Lake (Technical Comment No. F-DFO-TC-9). Of concern was the ability of Arctic Grayling from Goose Lake to access high quality spawning and rearing habitat within the upper reaches of Rascal Stream East (RSE; a tributary to Goose Lake) following construction of Project infrastructure expected to result in habitat losses in lower RSE (Figure 1.1-2).

Stream habitat losses in lower RSE will result from blocking fish access to the Goose Inflow East (GIE) and Goose Inflow South (GIS) streams. Reduced flow in these channels because of lost upstream catchment area may be sufficient to allow fish to enter and become stranded, perish, or to spawn and strand eggs (Figure 1.1-2). A 1.1 km section of RSE upstream of the airstrip culverts, nearest to the upstream Rascal Lake, will remain undisturbed and will continue to provide approximately 0.7 ha of habitat for spawning, rearing, and foraging Arctic Grayling, in addition to forage fish (e.g., Ninespine Stickleback, Slimy Sculpin, and Burbot). Following habitat losses in lower RSE, access to habitat in upper RSE from Goose Lake will require migration through Rascal Stream West (RSW; including Gander Outflow, Gander Pond, and Gosling Ponds 1 and 2; Figure 1.1-2). DFO has expressed concerns that Arctic Grayling will not be able to access upper RSE through RSW due to stream habitats in RSW that may, under certain open-water flow conditions, restrict the movement of fish (i.e., intermittent channelization, shallow depths, ephemeral flows, and poor connectivity with overwintering habitat, observed during baseline surveys).

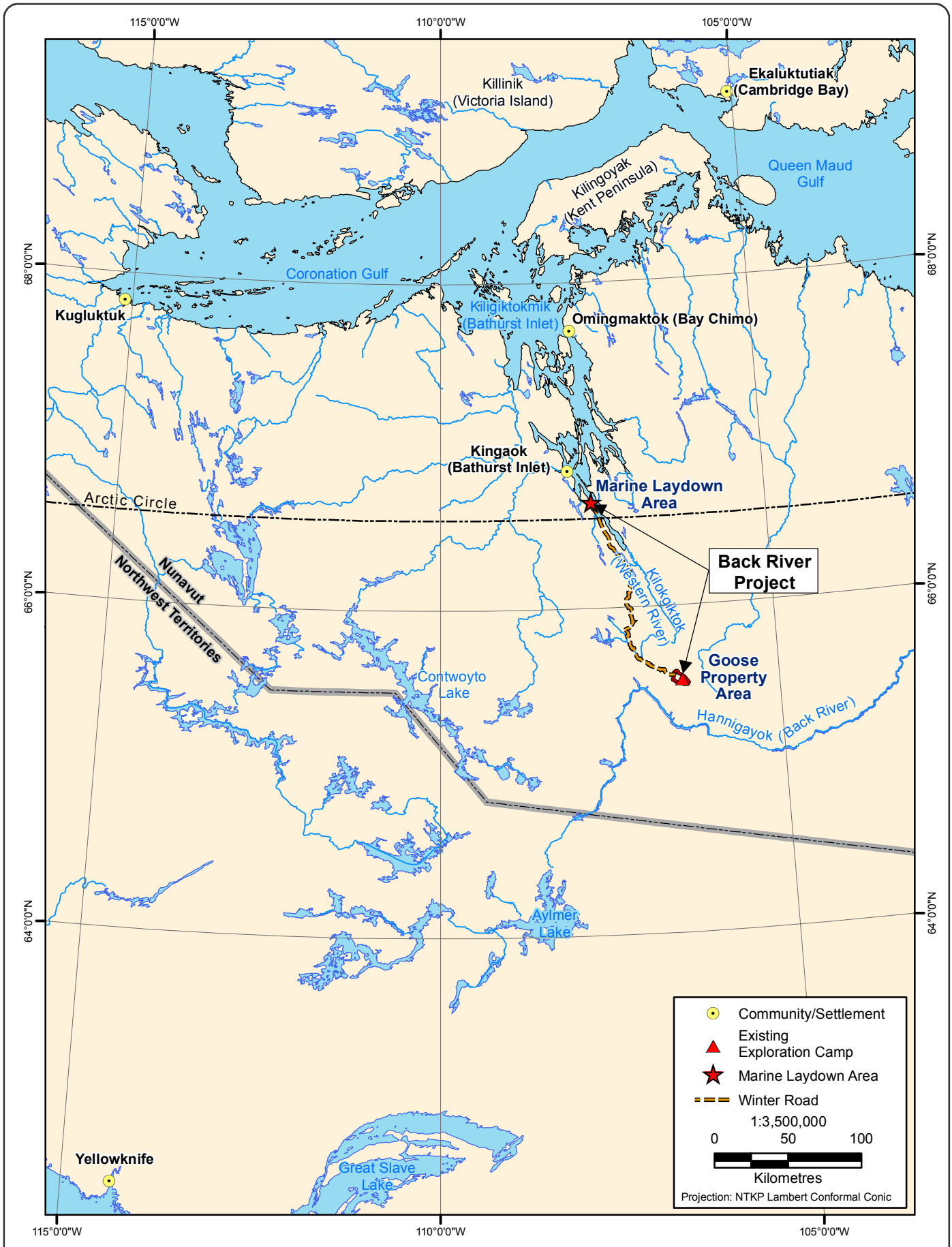

Figure 1.1-1

Back River Project Location

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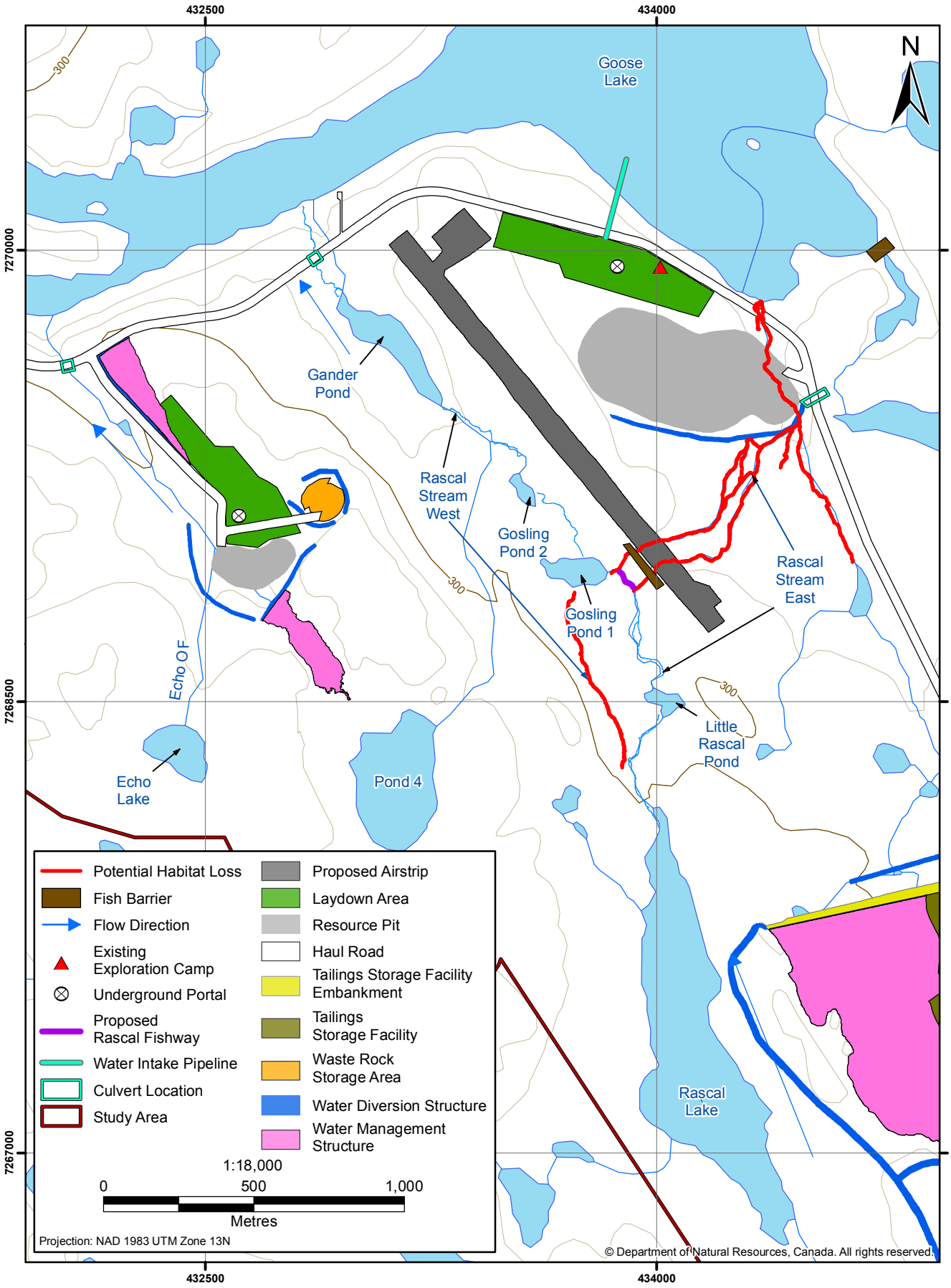

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Rascal Stream System and Proposed Rascal Fishway

Figure 1.1-2

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Sabina acknowledged DFO's concern over the migration potential between Goose Lake and spawning and rearing habitat in upper RSE via RSW. In response to Technical Comment No. F-DFO-TC-9, and following DFO's preference to mitigate rather than offset (DFO 2013a), Sabina proposed mitigation by design to ensure adequate fish passage between Goose Lake and upper RSE. The proposed fish passage mitigation included design, construction, and operation of a migratory fishway (i.e., the Rascal Fishway) between Gosling Pond 1 and upper RSE and the engineering/diversion of flow such that stream flow in RSW is sufficient to promote migration through the entire route from Goose Lake to upper RSE (Figure 1.1-2). Based on Sabina's response, the following proposed term and condition was generated by DFO and agreed to by Sabina during the FEIS final hearings:

DFO Proposed Term and Condition #2 (DFO-T-2):

The Proponent commits to engage DFO and other interested parties during the regulatory phase on the design, construction, and operation of adequate fish passage to permit migration of Arctic Grayling from Goose Lake to natural spawning and rearing habitat located in upper Rascal Stream East, south of the planned airstrip. Any additional information required to ensure the design of the fish passage will be completed prior to significant construction activities at the Goose Property.

This memorandum presents preliminary information on the design, construction, and operation of fish passage mitigation (i.e., the Rascal Fishway and subsequent flow diversion through RSW) with the primary objective of ensuring the migration potential of Arctic Grayling from Goose Lake to natural spawning and rearing habitat located in upper RSE via RSW. A monitoring program has also been proposed to determine if the fish passage mitigation, once operating, meets this objective.

1.2 Objectives

The objectives of this memorandum are to:

- Outline the basic design and construction considerations (including the alignment of the Rascal Fishway) and conceptual feasibility of fish passage mitigation in ensuring adequate fish migration potential between Goose Lake and natural spawning and rearing habitat in upper RSE;
- Describe the baseline study area of the fish passage mitigation;
- Characterize anticipated effects on fisheries, including access to spawning, rearing, and migratory habitats by Arctic Grayling, following construction of fish passage mitigation; and
- Outline a proposed monitoring program to ensure fish passage mitigation is functioning as intended.

2. ENVIRONMENTAL SETTING

2.1 Study Area

The study area described in this memorandum encompasses upstream and downstream fish habitat potentially affected by the construction of the Goose Main Open Pit, the TSF and associated infrastructure at the Goose Property (Figure 2.1-1), resulting in the requirement for fish passage mitigation. The proposed mitigation is located in the Wolf Watershed (Figure 2.1-1) with streams emptying into Goose Lake. The Wolf Lake Watershed is large with numerous lakes and ponds discharging first into Wolf Lake and subsequently into Rascal Lake.

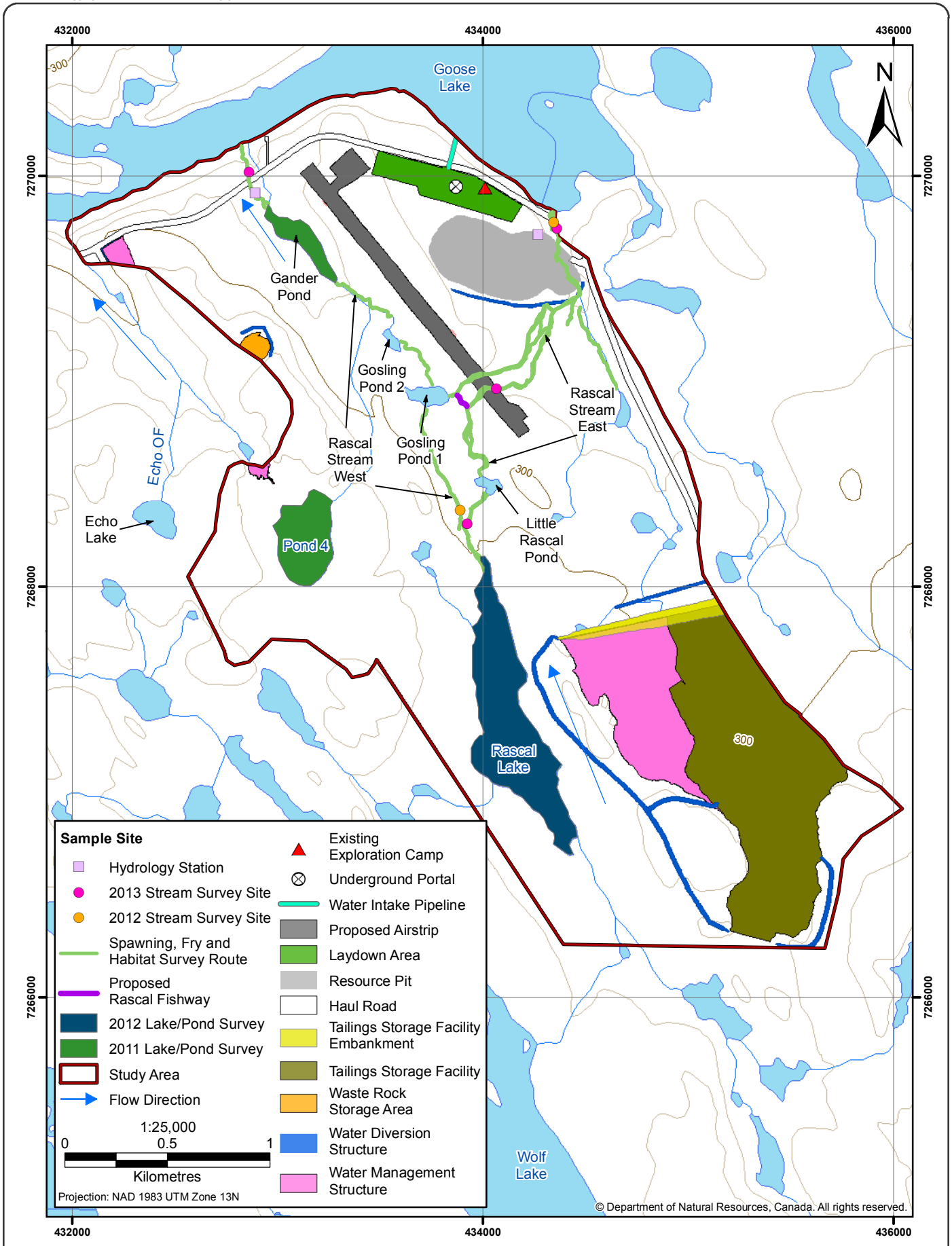
Approximately 250 m downstream of Rascal Lake, its outflow separates into two streams: RSE and RSW. RSE flows northeast towards Goose Lake, through the location of the proposed airstrip and the Goose Main Open Pit. RSW flows to the northwest initially passing through Gosling Ponds 1 and 2 and eventually through Gander Pond prior to reaching Goose Lake (Figure 2.1-1). A small outflow from Gosling Pond 1 also flows east into RSE. Baseline hydrological studies found that approximately 70% of water flowing out of Rascal Lake Outflow passes through RSE before entering Goose Lake during spring freshet; the remaining 30% flows northwards through RSW (Rescan 2012a, 2012b, 2014b). Discharge appears low in both streams during the later summer months and zero discharge was measured (i.e., 0 m^3/s) in RSW for periods of one to five weeks in three years of hydrometric monitoring (Station GL-H3; FEIS Volume 6, Chapter 1).

The conceptual design of fish passage mitigation in RSW and the characterization of potential effects on fisheries were described based on baseline data describing the study area collected from several sources. The primary data sources were baseline studies conducted by Rescan between 2011 and 2013 (Rescan 2012a, 2012b, 2012c, 2012d, 2012e, 2014a, 2014b). Figure 2.1-1 presents a summary of sites sampled.

2.2 Fisheries

Arctic Grayling are a relatively long lived (30+ years) iteroparous species that spawn early in the spring in small streams over a variety of substrates ranging from mud to boulders, although gravel is preferred (Scott and Crossman 1973; Hubert et al. 1985; Stewart et al. 2007). Juveniles tend to rear in these streams for most of the summer, while adults rear in lakes, to which they return after spawning (Table 2.2-1; Hubert et al. 1985). Both adults and juveniles overwinter in larger rivers and lakes upstream and downstream of spawning areas (Stewart et al. 2007). The preferred stream habitat characteristics for each life stage of Arctic Grayling are summarized in Table 2.2-2. In general, all life stages prefer shallow, moving water with gravel and cobble substrates. Adults prefer water velocities up to 119 cm/s and juveniles between 0 and 25 cm/s.

Baseline data were collected from RSE, RSW, Rascal Lake, Gander Pond, and Gosling Ponds to characterize fisheries resources in the waterbodies prior to construction of the airstrip at the Goose Property and subsequent fish passage mitigation activities (Figure 2.1-1). The following section summarizes the fisheries resources in each of these waterbodies.



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Sample Site Locations and Study Area

Figure 2.1-1

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Table 2.2-1. Life History Periodicity Table for Arctic Grayling

Species/Life Stage	Habitat	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arctic Grayling													
Spawning	Streams/Rivers												
Hatching	Streams/Rivers												
Fry rearing/migration	Streams/Rivers												
Rearing/overwintering	Rivers/Lakes												
Adult migration	Streams/Rivers												

Note: Information compiled from Scott and Crossman (1973) and from field observations.

Table 2.2-2. Preferred Habitat Characteristics for Each Life History Stage of Arctic Grayling

Habitat Features	Life Stage			
	Spawning Adults/eggs	Foraging Adults	Rearing and Foraging Fry	Rearing and Foraging Juveniles
Habitat Type	Clear, fast-flowing streams	Middle and upper reaches of small, clear tributaries in riffles, slow-moving shallows, and pools	Shallow pools and side channels of clear streams, in close proximity to where they hatched	Middle and lower reaches of small, clear tributaries in riffles, slow-moving shallows, and pools
Depth Range (m)	A few cm to 1 m	0.2 - 2.8 m; preference 0.5 - 1.34 m	0.05 - 0.85 m; preference 0.08 - 0.45 m; larger fish tend to move to deeper waters but not necessarily faster velocities	0.2 - 1.16 m; preference for 0.2 - 0.8 m
Velocity Range (cm/s)	<150 cm/s, optimal velocities 34 - 119 cm/s	<150 cm/s; optimal velocities 25 – 90 cm/s	<80 cm/s; optimal velocities 0 - 15 cm/s	<50 cm/s; optimal velocities 0 - 25 cm/s
Substrate Size	Clean substrates; unemdedded gravel (including pea-sized), sand, rubble	Gravel, large boulder and cobble	Silt to boulder, with a preference for sand and fine gravel (depends on presence of other species)	Silt to boulder, with a preference for sand and fine gravel with cobble
Cover	Preferred cover is sometimes under ice; eggs in interstices or gravel substrate to a depth of 5 cm	Preferred abundance of cover > 25 cm in size, deep pools	Preferred cover is in substrates (gravel to boulder), overhead vegetation also used	Preferred cover is rocks, cut banks or overhanging/instream vegetation

Note: Data obtained from Stewart et al. (2007), Hubert et al. (1985) and Larocque et al. (2014)

2.2.1 Rascal Stream East (RSE)

RSE is the main migratory corridor for Arctic Grayling moving between the Goose and Wolf watersheds throughout the open-water season and likely provides a critical pathway for fish migrating between summer and winter rearing habitat. Rascal Lake has a maximum depth of 3.7 m and, along with Goose Lake, likely provides overwintering habitat to fish that rear in both West and East Rascal streams.

Electrofishing, fry and spawner surveys show that Arctic Grayling utilize the full length of RSE for spawning and rearing. In addition, fry, spawner, and habitat surveys completed on inflows and outflows to Goose Lake suggest that RSE has the most abundant and highest quality Arctic Grayling spawning habitat available to the overwintering population in Goose Lake. Populations overwintering upstream in Rascal Lake and downstream in Goose Lake may use the stream as a migration corridor when moving between summer and winter habitat.

The flow and substrate composition within RSE indicate that it provides good quality spawning and rearing habitat to Arctic Grayling, Slimy Sculpin, and Ninespine Stickleback (Rescan 2014a). RSE was found to have the highest juvenile fry densities (1,122 fry) in the Goose Property area (Figure 2.2-1). Electrofishing was completed at three sites in RSE in 2013 (Figure 2.1-1; Table 2.2-3). At two sites, located under the proposed airstrip in RSE (Site 1101 and 1004, both approximately 100 m in length), a total of 15 Arctic Grayling and 11 Slimy Sculpin were captured during 525 s of electrofishing on August 11, 2013 (Rescan 2014a).

Extensive high flow (i.e., during freshet) fish habitat assessment surveys were completed for RSE in June 2013 using SHIM (Rescan 2014a). These surveys identified seven reaches between Goose and Rascal lakes (Figure 2.2-2). Overall, the upstream reaches of RSE near Rascal Lake are a mixture of braided channels intermixed with run and riffle sections with gravel, cobble and boulder substrates rated as important for Arctic Grayling spawning, rearing and foraging (Rescan 2014a).

Table 2.2-3. Fish Species Captured in Study Area Waterbodies at the Goose Property Area, 1997 to 2013

Waterbodies Sampled	Species						
	Lake Trout (*Salvelinus namaycush*)	Round Whitefish (*Prosopium cylindraceum*)	Lake Whitefish (*Coregonus clupeaformis*)	Arctic Grayling (*Thymallus arcticus*)	Burbot (*Lota lota*)	Slimy Sculpin (*Cottus cognatus*)	Ninespine Stickleback (*Pungitius pungitius*)
Rascal Lake	X	X	-	X	-	-	-
Goose Lake	X	X	X	X	X	X	X
RSE	-	-	-	X	-	X	X
RSW	-	-	-	X	X	X	X
Gander Pond	-	-	-	X	-	X	X

2.2.2 *Rascal Stream West (RSW)*

RSW flows from Rascal Lake through Gander Pond and into Goose Lake. Arctic Grayling, Burbot, Slimy Sculpin, and Ninespine Stickleback have been caught in Gander Pond and RSW (Table 2.2-2; Rescan 2014a). A fry survey of RSW in 2013 found that Arctic Grayling do utilize this stream, but in far lower densities than in RSE (99 individuals, Figure 2.2-3).

RSW has three reaches between its divergence from RSE and Goose Lake (Figure 2.2-4). The reach between Gander Pond and Goose Lake (Reach 1) has abundant instream cover, heterogeneous habitat types (riffle, pool, run, and cascade), and good rearing habitat. There are also some patches of gravel and cobble substrate that may provide spawning habitat.

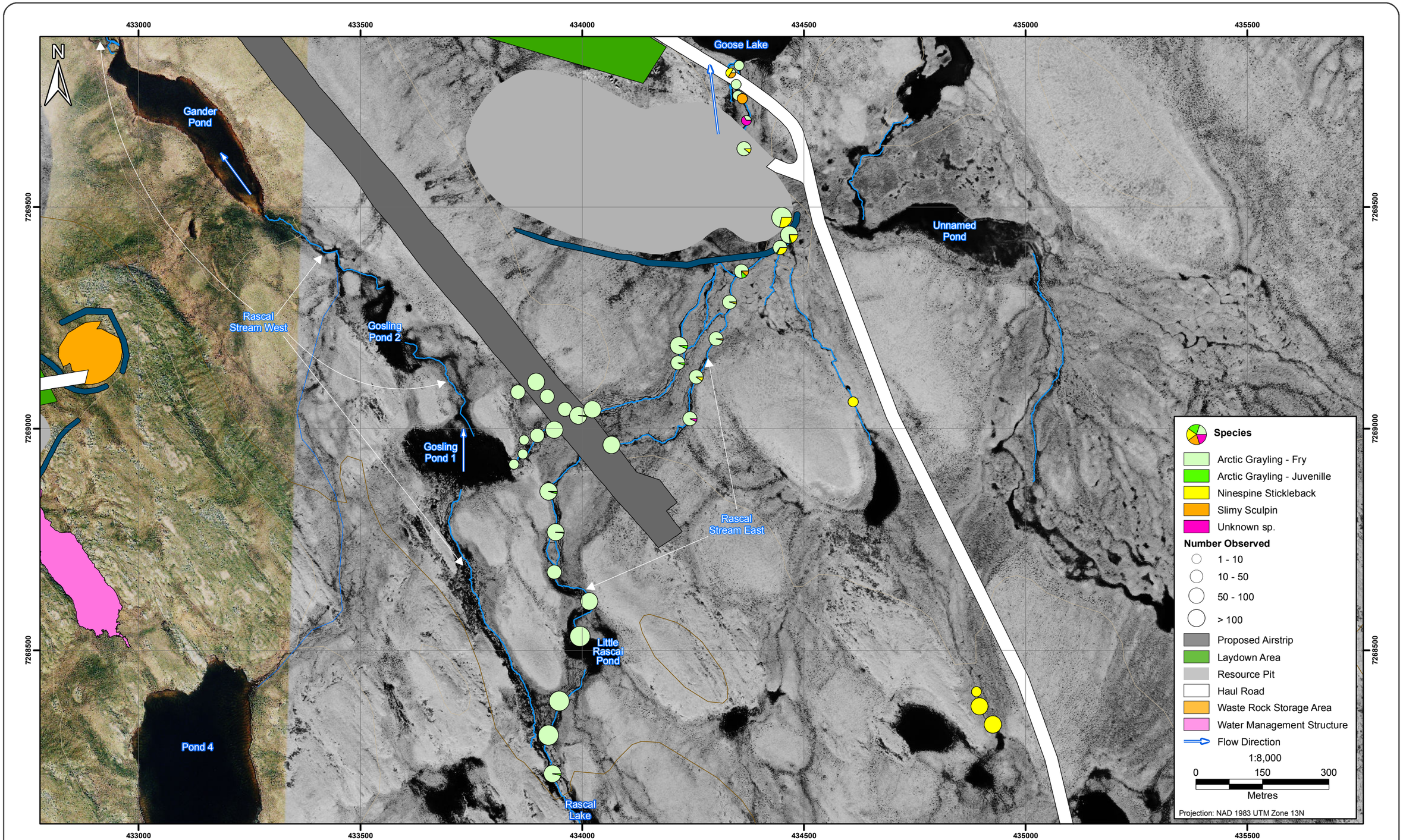

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Figure 2.2-1

Rascal Stream East
Fry Survey Observations, 2013

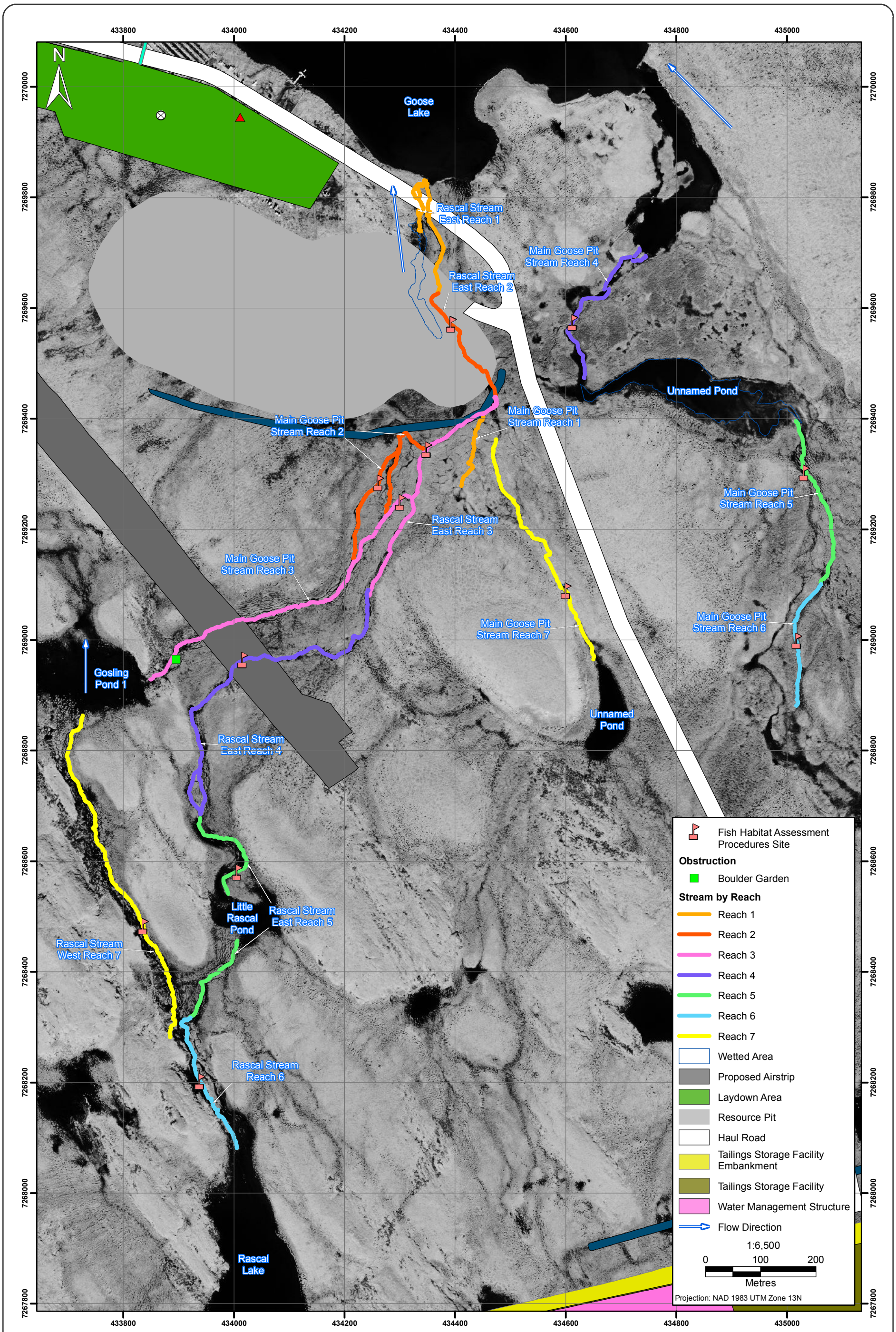

Figure 2.2-2

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Rascal Stream East and Main Goose Pit Stream Reaches and Survey Sites, 2013

Figure 2.2-2

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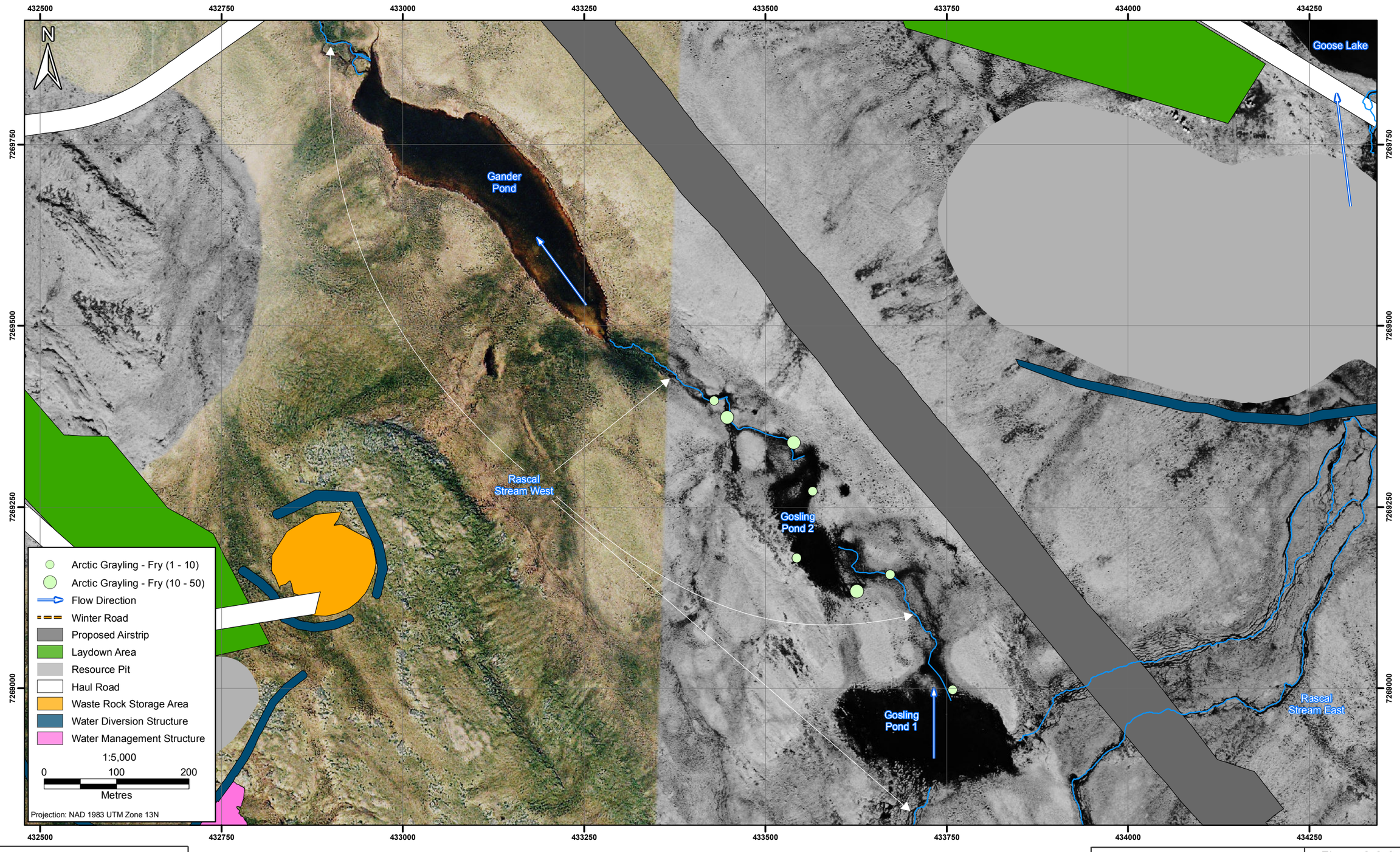

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Figure 2.2-3

Rascal Stream West
Fry Survey Observations, 2013

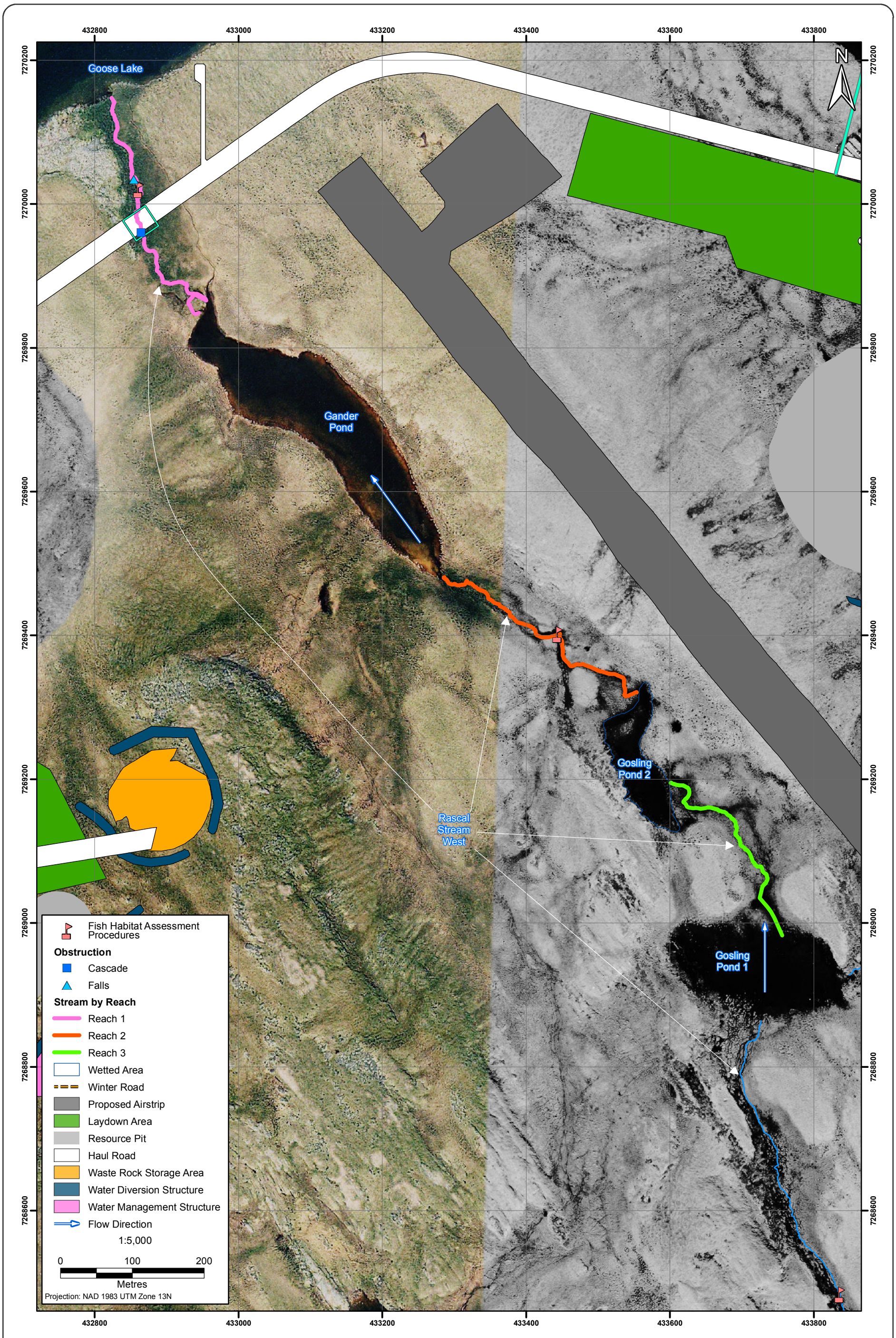

Figure 2.2-4

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Rascal Stream West Stream Reaches and Survey Sites, 2013

Figure 2.2-4

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A small cascade located mid-reach may form a barrier to fish migration during periods of low flow, but does not form a barrier during high flow periods (Figure 2.2-4). A second cascade further downstream does not form an impassable barrier to fish but may prevent very small fish from moving upstream at low flows (Figure 2.2-4). If during the course of monitoring stream flow and fish passage (section 5) through this reach reveals that a partial barrier exists at this location, a plan will be developed to modify the channel to facilitate fish access to RSW.

The remaining two reaches (between Gander Pond and Gosling Ponds 1 and 2) are of marginal fisheries value (Rescan 2014a). Channelization is intermittent at Reach 2 (between Gander Pond and Gosling Pond 2), the Gander Pond inflow with low bankfull depth (0.15 m) indicating this reach is shallow at normal flows. The substrate is primarily fine substrate with some embedded boulder and cobbles. The quality of the habitat for rearing is fair, although the intermittent channelization and shallow depths make it unsuitable for larger stream fish. Spawning habitat is poor due to the high proportion of fine sediments. Reach 2 has marginal fish habitat overall from the intermittent channelization.

2.2.3 Gosling Ponds and Gander Pond along Rascal Stream West (RSW)

Gosling Ponds 1 and 2 are shallow waterbodies that are located between Rascal Lake (upstream) and Gander Pond (downstream) on RSW (Figure 2.2-1). Both ponds are likely shallow (< 1 m depth) with predominately fine substrates. In August 2013, the inflows and outflows of Gosling Pond 1 and 2 contained isolated pools; there was no flow in the channel at that time (Rescan 2014a). Arctic Grayling fry were observed in both ponds at relatively low numbers: likely the result of ephemeral flow conditions in the inflows and outflows, and poor connectivity to overwintering habitat (Figure 2.2-3).

Gander Pond is located downstream of Gosling Ponds 1 and 2 and it drains north into Goose Lake (Figure 2.2-4). The shoreline of Gander Pond is composed almost entirely of fine sediment (Figure 2.2-5). One permanent inflow and two ephemeral inflows were present during habitat surveys in July 2011, and the pond has one outflow to Goose Lake (Rescan 2012c). Gander Pond has a maximum depth of approximately 1.5 m. Habitat quality of Gander Pond is poor due to its shallow nature and due to the near total absence of cover available to fish.

3. PROPOSED ACTIVITIES

3.1 Fish Passage Mitigation Activities

The proposed fish passage mitigation will include the construction of the Rascal Fishway and the subsequent diversion of flow through the Rascal Fishway and downstream through RSW (Figure 1.1-2). The proposed timing for the construction of the Rascal Fishway is in Year -3 (Table 3.1-1).

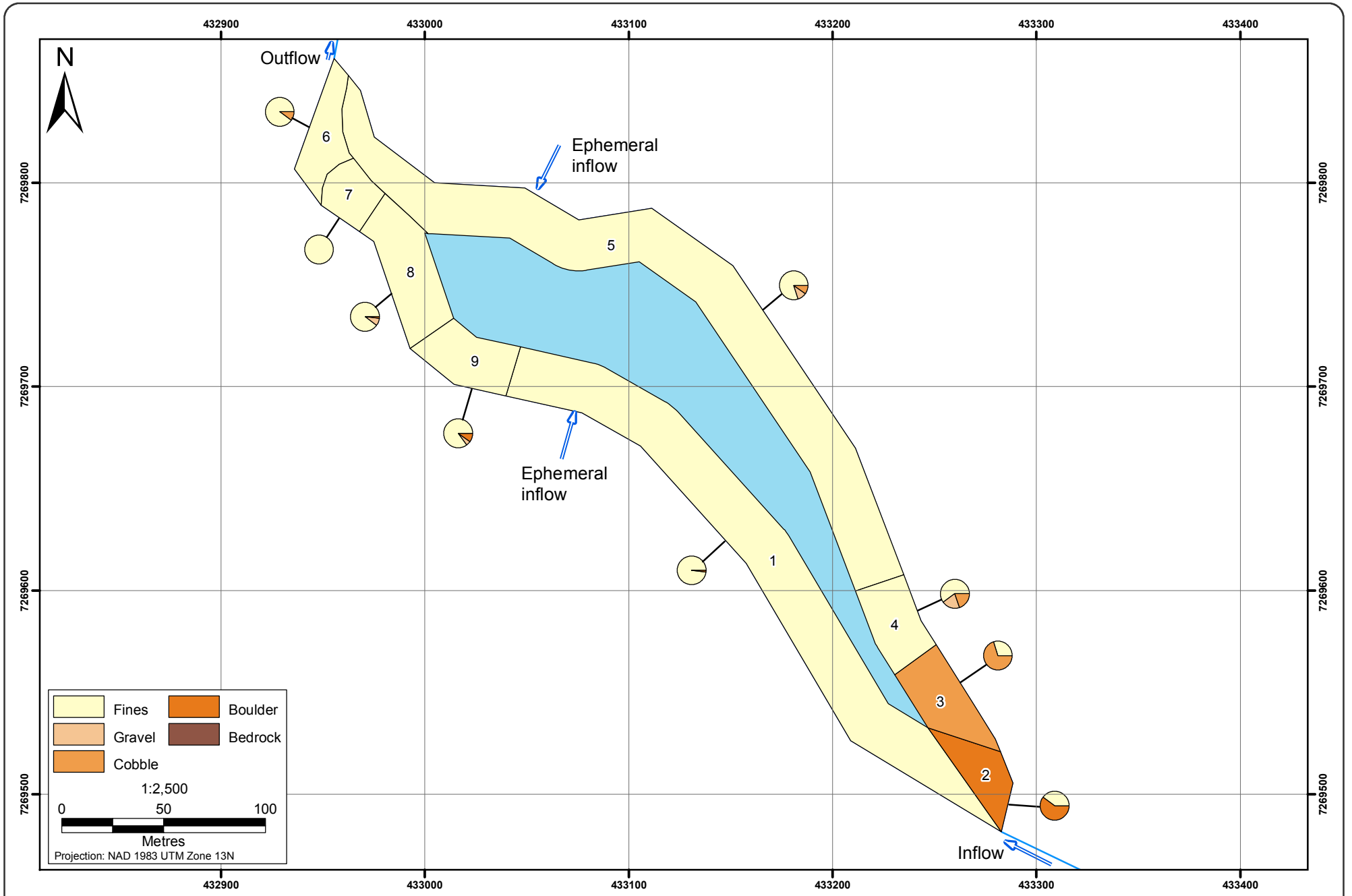

Figure 2.2-5

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Shoreline Substrate of Gander Pond

Figure 2.2-5

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Table 3.1-1. Timing of Proposed Fish Passage Mitigation Activities

Activity	Year 1	Year 2	Year 3 to 6
Fisheries Losses	RSW (Reach 7; potential loss due to water diversion)		
Construction	Installation of berms and/or excavation, lining, and armouring of alignment during Rascal Fishway construction and flow diversion. Installation of culverts during airstrip expansion and road construction.		
Mitigation	Placement of sediment curtains to minimize sediment/erosion potential downstream into Goose Lake.		Sediment/erosion control measures.
Monitoring	Hydrological and fisheries assessments during high (freshet) and low (summer) flows.	Hydrological and fisheries assessments during high (freshet) and low (summer) flows.	Hydrological and fisheries assessments during high (freshet) and low (summer) flows in Years 3, 5 and 6.
	Arctic Grayling and Fish Habitat Monitoring.	Arctic Grayling and Fish Habitat Monitoring.	Arctic Grayling and Fish Habitat Monitoring in Years 3, 5 and 6.

The proposed alignment of the Rascal Fishway (Figure 1.1-2) was mapped using local 25 cm Lidar imagery. The alignment, located between upper RSE and the south-eastern edge of Gosling Pond 1, attempts to follow the most likely natural flow path, minimizing any rises in elevation that could result in misdirected flow, and potentially require excavation during construction. Depending on the final alignment selected for the fishway, construction may entail diverting flow using rock berms to follow a natural over-land flow path between upper RSE and Gosling Pond 1 and/or excavation, lining with a geotextile membrane, and armouring with rock over some or all of the alignment to achieve the desired flow path between upper RSE and Gosling Pond 1.

The Rascal Fishway will be designed with the objective of creating a migratory corridor between Gosling Pond 1 and upper RSE; however, the stream habitat created along the length of the fishway alignment may also serve as spawning or rearing habitat for fish. The final design and construction of the Rascal Fishway will consider depth and velocity constraints for migration of all life stages of Arctic Grayling (Table 2.2-2), though the design criteria are primarily focused at allowing passage for spawning adult Arctic Grayling to access the spawning habitat in upper RSE near Rascal Lake. As such, the water velocity range through the fishway should range between 5 to 120 cm/s, with higher velocities at freshet of up to 150 cm/s to correspond with the timing and preference of adult spawners (Table. 2.2-2). Preferred substrates lining the fishway stream bed will be cobble and unembedded gravel, which will provide spawning substrates in addition to rearing and foraging habitat for fry and juveniles as water velocities decline naturally through the summer. Adults, juveniles and fry appear to have a relatively wide range of preferred water depth, from a few centimeters to one meter. The ideal depth of the fishway will be no more than 1 m during freshet.

Operation of the Rascal Fishway may entail the diversion of flow away from the upper-most section of RSW (Rascal Stream West Reach 7 in Figure 2.2-2; identified as potential habitat loss in Figure 1.1-2) to flow through upper RSE. Then, a portion of the water will be diverted through the new Rascal Fishway connecting upper RSE to Gosling Pond 1. The remainder of the water will be directed through culverts under the airstrip towards the southern portion of Goose Lake, as previously planned and assessed in the FEIS (Sabina 2015). The diversion of flow from upper RSE into Gosling Pond 1 will be engineered such that flow is sufficient to allow for upstream and downstream migration of all life stages of Arctic Grayling through the entire route from the Gosling ponds through Gander Pond and ultimately to Goose Lake. This strategy will ensure that the upper 1.1 km section of RSE will continue to provide good quality spawning and rearing habitat to Arctic Grayling from Goose Lake, now accessed through RSW. Natural or constructed fish barriers will be used to keep fish from moving north, through the airstrip culverts, to the east side of the airstrip. A monitoring program will be implemented following mitigation activities (Section 5). If, during monitoring, barriers or seasonal restrictions to fish movement are identified in RSW, the Rascal Fishway, or upper RSE those locations may need to be adaptively managed to improve egress.

Creation of a stream channel between upper RSE and Gosling Pond 1, and the diversion of flow from upper RSE toward RSW have been previously considered and determined conceptually feasible (Rescan 2014c). In this document, the methods outlining flow modeling used to verify that adequate stream flow for Arctic Grayling migration can be conceptually attained through diversion of flow from upper RSE through RSW can be found in detail. A channel with a flow path similar to the proposed alignment of the Rascal Fishway was designed through the use of two rock berms placed just north of Gosling Pond 1. These berms were designed to divert 100% of the flow from upper RSE toward Gosling Pond 1, and subsequently downstream through RSW. Flow modelling of this diversion scenario resulted in modelled stream flows that were generally <1.0 m/s in June and <0.8 m/s in the fall over the length of RSW (including Gosling Ponds 1 and 2, and Gander Pond; Rescan 2014c). Modelled fall flows in stream habitats along the channel (excluding Gosling Ponds 1 and 2, and Gander Pond), were between approximately 0.2 and 0.7 m/s (Rescan 2014c). These modelled flows indicated acceptable velocities to allow for Arctic Grayling migration throughout RSW during the open water season (Rescan 2014c).

The final design of the fish passage mitigation will rely upon new flow modelling. This is needed to determine the amount of water from upper RSE that may be diverted through the Rascal Fishway into Gosling Pond 1 to ensure adequate depth and velocity for Arctic Grayling migration through RSW over the open water season. The proportion of diverted flow required from upper RSE is anticipated to be less than 100%.

3.2 Culvert Installation

To facilitate fish passage across the proposed all-weather road, culverts will be installed approximately 109 metres upstream of the inflow of RSW to Goose Lake (Figure 1.1-2). Culverts will be sized based on the post-mitigation flow diversion scenario described in Section 4.1. All rock used as construction material will be sourced from locally developed, geochemically suitable rock quarries already permitted or under application. The proposed time for installation is during the spring of Year 1 (Table 3.1-1), prior to snow melt and fish access to the streams.

4. CHARACTERIZATION OF EFFECTS AND MITIGATION

4.1 Characterization of Effects on Fisheries

4.1.1 Habitat Losses in RSW and RSE

An approximately 740 m section of upper RSW (Rascal Stream West Reach 7 in Figure 2.2-2; identified as potential habitat loss in Figure 1.1-2) may be lost through the operation of the Rascal Fishway. Operation may entail the diversion of flow away from this upper-most section of RSW to flow through upper RSE. This section of stream was characterized as a boulder garden during baseline studies (labeled Reach 7 of the Rascal Goose Stream; Table 3.3-2 in Rescan 2014a) and is deemed as poor to fair spawning habitat. This reach may become seasonally impassable to fish during low flow periods due to the abundance of large, closely packed boulders, and may restrict movement between RSW and RSE under natural flow conditions (Rescan 2012d). Sabina will incorporate the 740 m section of RSW into the next revision of the Conceptual Fish Offsetting Plan (FEIS Addendum Volume 10, Chapter 21).

Potential habitat losses in RSE downstream of the airstrip culverts (Figure 1.1-2) were assessed in the FEIS and offsetting was incorporated into the Conceptual Fish Offsetting Plan.

4.1.2 Access to Habitats in RSE, the Rascal Fishway, and RSW

Construction of the Rascal Fishway and diversion of flow from upper RSE through RSW will mitigate the effects of potential habitat losses in lower RSE for fish from Goose Lake, particularly Arctic Grayling that use high quality habitats in upper RSE, by ensuring fish passage during migration. The upstream reaches of RSE near Rascal Lake that will be accessible to fish from Goose Lake comprise a mixture of braided channels intermixed with run and riffle sections with gravel, cobble, and boulder substrates rated as important for Arctic Grayling spawning, rearing, and foraging (Rescan 2014a).

Although the Rascal Fishway will be specifically designed as migratory habitat to allow spawning Arctic Grayling passage between Gosling Pond 1 and spawning habitat in the upper RSE, resulting habitat conditions along the Rascal Fishway alignment may also be appropriate for use as spawning and/or rearing and foraging habitat by Arctic Grayling and other fish species such as Ninespine Stickleback, Slimy Sculpin, and Burbot. These species are already found to inhabit RSW in low densities (Table 2.2-3), despite fair to marginal baseline conditions in RSW between Gosling Pond 1 and 2. Thus, increasing access to good rearing and spawning habitat located in upper RSE through the fishway may also increase fish productivity overall species present.

4.1.3 Sedimentation and Erosion in RSW

Increased sedimentation and erosion may occur as a result of construction near and within the stream channel and through increased flow in the re-aligned stream. The construction of berms and culverts will occur during winter, when stream habitat is frozen and absent of fish, and where particulate matter suspension is avoided. Increased flow resulting from the stream re-alignment has the potential to increase the erosive potential and the amount of suspended material, particularly during freshet and in the year immediately following construction. The suspension of fine particulate matter could

result indirectly in decreased Arctic Grayling production because of behavioural avoidance of turbid sections of stream, or directly by smothering eggs laid within the channel. This could result in fewer migrants between Rascal and Goose lakes, leading to decreased spawning production.

4.2 Identification of Mitigation and Management Measures

4.2.1 Habitat Mitigation

During the regulatory phase, Sabina will update the Conceptual Fish Offsetting Plan (FEIS Addendum Volume 10, Chapter 21) to include an approximately 740 m section of upper RSW as habitat lost. This section of potential habitat loss is identified as Rascal Stream West Reach 7 in Figure 2.2-2.

4.2.2 Mitigation for Erosion and Sedimentation

Experience with other arctic diversion channels has shown that sediment can be mobilized from a new stream channel and/or from disturbed areas through thermal degradation, and transported downstream immediately after freshet flows begin in late May/early June.

During freshet of Year 1, releases in sediment are expected to occur following the winter construction of berms and culverts, potential excavation and construction of the Rascal Fishway alignment, and increased channel flows over the length of RSW due to flow diversion. Increased suspended sediment will be mitigated naturally in the three ponds (Gander, Gosling 1 and 2) where low velocities (Rescan 2014c) should result in deposition of a large portion of suspended solids. The result will be a natural lowering of concentrations of suspended solids in the water between pond reaches, and most importantly, in the most downstream reach located just upstream of Goose Lake where Arctic Grayling could enter the re-aligned stream to spawn and migrate. Moreover, the relatively flat topography over the length of the enhanced RSW should allow for additional settling onto the tundra should flows overtop existing banks.

In the event that particulates do not adequately settle prior to leaving Gander Pond, sediment curtains will be installed in Goose Lake at the mouth of RSW, to mitigate for the potential of sediments entering Goose Lake. Sediment curtains will be placed in an overlapping configuration, such that the majority of suspended particulates are captured, but also such that fish may pass between curtains and migrate between stream and lake habitats.

4.2.3 Construction Schedule and Environmental Mitigation Measures

4.2.3.1 Construction Period

The schedule for construction is presented in Table 3.1-1. Any rock berm construction, excavation, and channel lining and armoring will take place in or prior to April of Year 1 when the ground is still frozen. During the first winter season, heavy machinery can move freely around the site with limited damage to the tundra. Substrates used for construction of berms or channel armoring will be composed of clean rock (i.e., non-potentially acid generating rock). Any increase in sediment loading resulting from construction will be managed according to mitigation set out in section 4.2.2.

Detailed hydrological and fish habitat assessments will be conducted in Year 1 (see Proposed Monitoring Program, Section 6) at both high (freshet) and low flows. These surveys will allow for the identification of any adaptive management required to establish or maintain fish passage. Any additional in-water work/structures required will be designed and adapted to conditions observed and will be implemented the following winter (i.e., Year 2).

4.2.3.2 Sources of Substrate

Sources of substrate for construction of fish passage mitigation may include natural boulder and cobble substrates dug up during construction or substrates remaining in lost habitat in upper RSW (Rascal Stream West Reach 7 in Figure 2.2-2) following flow diversion. If required, these substrates will be separated from unwanted materials and retained. These substrates may be used in armouring the Rascal Fishway or for subsequent adaptive management required along the length of RSW downstream of the Rascal Fishway. Larger substrates (i.e., boulders) will be retained for potential placement in culverts. Substrate materials larger than sand will be washed (whenever feasible) prior to use to reduce the amount of small particles. Only clean (i.e., non-potentially acid generating substrates) will be used.

4.2.3.3 Culvert Placement

Placement of box culverts (sea cans) or circular culverts located at meter 96 between Goose Lake and Gander Pond will occur during the winter to minimize/eliminate damage to the tundra. Culverts will be installed following best practices (BC MFLNRO 2012, DFO 2013b). Sizing of culverts to be placed will be determined such that they do not present a velocity barrier to migrating fish present in RSW (Table 2.2-3).

Regular culvert maintenance will be performed on an ongoing basis in order to prevent culvert blockage and will generally follow the DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013b). Specifically, culverts will be blocked prior to winter to prevent snow from accumulating inside the culvert and blocking flows during freshet, which would have the potential of overflooding the area, possibly leading to sedimentation and erosion.

5. PROPOSED MONITORING PROGRAM

5.1 Overview

A monitoring program will be implemented to determine if the proposed Rascal Fishway is functioning effectively as migratory habitat for Arctic Grayling. This proposed Monitoring Program will commence during Year 1, synchronous with the expansion of the airstrip, construction of the all-weather road and implementation of fish passage mitigation activities. In order to monitor the potential for fish passage and the effectiveness of flow diversion under variable annual flow conditions, monitoring will occur annually during Years 1, 2, and 3, then again in Years 5 and 6 after the new habitat has had time to settle/stabilize and mature, and following the removal of the all-weather road culverts. If the all-weather road culverts are removed at a later date, then the Monitoring Program will be modified to include monitoring during and after the culvert removal.

The main objective of the Monitoring Program is to evaluate the effectiveness of the Rascal Fishway and flow diversion through RSW in ensuring adequate passage of Arctic Grayling between Goose Lake and upper RSE. Because the pre-mitigation RSW supports fisheries under baseline conditions, a further objective of the Monitoring Program is to ensure that no serious harm to fish results from migration mitigation activities. "Serious harm" is defined in the *Fisheries Act* (1985) as the death of fish or any permanent alteration to, or destruction (PAD) of fish habitat.

5.2 Monitoring Program Schedule and Design

Table 5.2-1 presents the proposed schedule for the Monitoring Program. The Monitoring Program will assess Arctic Grayling, fish community, fish habitat, stream flow, and water quality for the first 3 years following installation of the Rascal Fishway and initiation of flow diversion, then again in years 5 and 6.

Table 5.2-1. Monitoring Program Schedule and Design Summary

Monitoring Program Design Year	Year 1 Construction Year	Post-Mitigation Monitoring			
		Year 2	Year 3	Year 5	Year 6
Monitoring Component					
Stream flow	X	X	X	X	X
Water quality[1]	X	X	X	X	X
Fish habitat[1]	X	X	X	X	X
Number of Arctic Grayling spawners[1]	X	X	X	X	X
Visual counts of Arctic Grayling fry[1]	X	X	X	X	X
Fish Community Surveys	X	X	X	X	X
Number of outmigrant Arctic Grayling/other fish	X	X	X	X	X
Fish culvert passage assessment	-	X	-	-	-

Notes:
Monitoring of project construction is not included, but required during Rascal Fishway and water diversion berm construction and culvert installation.
[1] Pre-mitigation data collected in 2013 for RSE and RSW (Rescan 2014a).

5.3 Detailed Monitoring Methods

5.3.1 Stream Flow

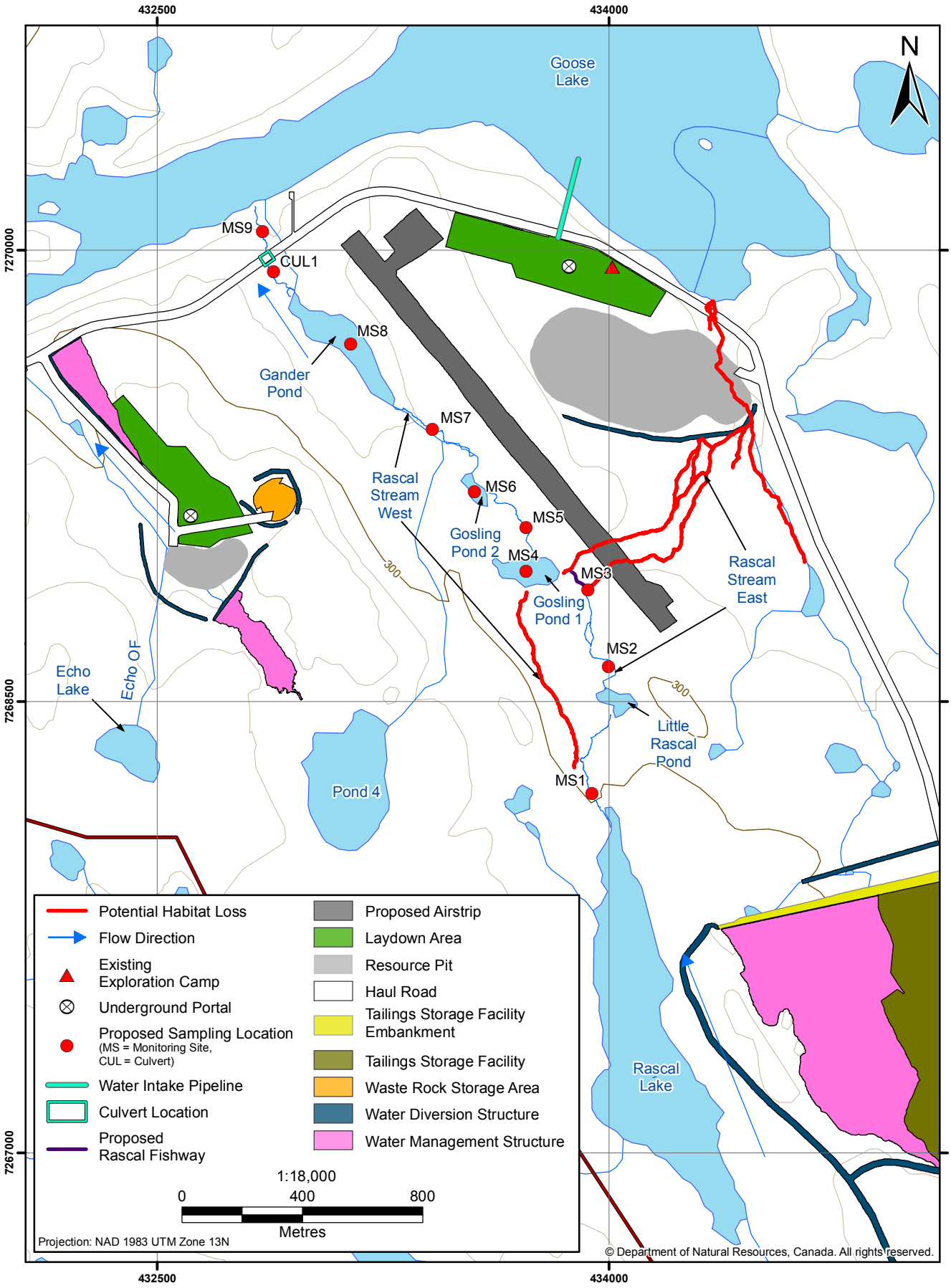
Detailed hydrological assessments including stream velocity and channel profiles will be required to confirm predicted flows following construction of the Rascal Fishway and diversion of flow through RSW. Hydrological assessments will be taken monthly during the open-water season at five transects along each reach of RSW and RSE (i.e., five reaches; between ponds), as well as at five transects in the Rascal Fishway. Hydrological assessments will provide depth and velocity data to determine if flow conditions are within the range of values to support the Arctic Grayling life cycle. In addition, velocity measurements will be taken at the upstream and downstream ends of each culvert (and within each culvert) to ensure Arctic Grayling migration is not restricted by culvert velocities.

5.3.2 Water Quality

Construction activities and erosion resulting from increased flows in stream channels have the potential to result in increased suspended sediments in RSW. To ensure that water quality remains within Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life or at natural background concentrations, water quality will be monitored at nine locations within the study area (Figure 5.3-1; Table 5.3-1). Water temperatures will be monitored with stationary data loggers installed at each water quality sampling station. Manual measurements will also be taken each time data are collected.

5.3.3 Fish Habitat

Following construction of the Rascal Fishway, initiation of diversion of flow through RSW, and culvert installation, fish habitat surveys will be conducted along the length of RSW, the Rascal Fishway, and upper RSE using SHIM twice per year, once during high and once during low flows. Fish habitat assessments will be used to ensure the mitigation meets migration habitat requirements for all life stages of Arctic Grayling and to identify any impediments to Arctic Grayling migration that may arise as the channel stabilizes/settles following construction and initial flow diversion. Fish habitat assessments will also allow for assessment of the continued suitability of the mitigation habitat for use by other fish species present in RSW (i.e., Ninespine Stickleback, Burbot, and Slimy Sculpin)



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Proposed Monitoring Program Sampling Locations

Figure 5.3-1

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Table 5.3-1. Proposed Sampling Sites between Rascal and Goose Lakes

Location	Site	Approximate UTM Coordinates (Zone 13N)		Adult Fish Migration	Culvert Passage	Fry Outmigration	Fish Community	Water Quality
		Easting	Northing					
RSE (downstream of Rascal Lake)	MS1	433964	7268146	X	-	X	X	X
RSE (downstream of Little Rascal Pond)	MS2	433999	7268616	-	-	-	X	X
RSE (upstream of Rascal Fishway)	MS3	433930	7268871	X	-	X	X	X
Gosling Pond 1	MS4	433724	7268933	-	-	-	X	X
RSW (between Gosling ponds 1 and 2)	MS5	433741	7269108	-	-	-	X	X
Gosling Pond 2	MS6	433554	7269199	-	-	-	X	X
RSW (upstream of Gander Pond)	MS7	433390	7269367	X	-	X	X	X
Gander Pond	MS8	433143	7269688	-	-	-	X	X
Upstream of Culvert	CUL1	432886	7269929	-	X	-	-	-
RSW (upstream of Goose Lake)	MS9	432844	7270030	X	X	X	X	X

Notes:
RSW = Rascal Stream West, RSE = Rascal Stream East, MS = Monitoring Site.
Each site will encompass a 100 m section of stream.
The upstream and downstream limits of each site will be determined during Year 1 of the monitoring program.

5.3.4 Arctic Grayling Spawner and Adult Spring Migrant Monitoring

Along with visual spawner counts conducted at the onset of spring melt, Arctic Grayling spawners and migrants will be enumerated as they move between Rascal and Goose lakes via RSW, the Rascal Fishway, and upper RSE using fish boxes according to the schedule set out in Table 5.2-1. Four fish boxes will be installed in the spring to track migrations as soon as water begins to flow and boxes will be removed when spawner numbers decline to zero, typically occurring at the end of June. One fish box will be located at the outlet of Rascal Lake (Site MS1), and another box will be located at the inflow to Goose Lake (Site MS9; Table 5.3-1) to determine the origin of Arctic Grayling spawners accessing the stream. Two additional fish boxes will be located between Goose and Rascal lakes, one directly upstream of the Rascal Fishway (Site MS3), and one downstream of Gosling Pond 2 (Site MS7; Table 5.3-1). These boxes will provide information on access to and use of the Rascal Fishway and downstream reaches of RSW affected by flow diversion by Arctic Grayling spawners. The ratio of visual-survey-fish-counts to box-trap-counts will also be calculated to examine for potential visual underestimation during the spring spawner surveys.

The fish boxes will be serviced once each day during peak spawning migration and once every two days after peak migration. During each visit, all fish will be counted, identified to species, sub-sampled for length and weight, and released in the direction they were swimming. All Arctic

Grayling ≥ 170 mm long will be tagged with a unique T-bar Floy Tag attached below the dorsal fin. Tagging of Arctic grayling will allow for evaluation of fish movement patterns and stream residence times, in addition to fish passage through the stream, the Rascal Fishway, and installed culverts, and it will also indicate what proportion of the population spawning in the Rascal Stream system overwinters in Rascal Lake or Goose Lake.

If barriers or seasonal restrictions to fish movement are identified in RSW, the Rascal Fishway, or upper RSE during adult migrant monitoring, those locations may need to be adaptively managed to improve access.

5.3.5 Summer Fish Community Surveys

Summer fish community surveys will be conducted according to the schedule set out in Table 5.2-1. Newly-emerged Arctic Grayling fry will be enumerated in early to mid-July to help determine if RSW, the Rascal Fishway, and upper RSE are being accessed successfully for spawning. Fry will be counted using timed walking surveys of the entire length of stream habitat located between Rascal and Goose lakes, including RSW, the Rascal Fishway, and upper RSE.

Electrofishing surveys will also be conducted to determine which fish species have access to/utilize habitats in RSW, the Rascal Fishway, and upper RSE following fish passage mitigation. These electrofishing surveys will take place in mid-August at the locations listed in Table 5.3-1. Fish length and weight measurements will be taken during the electrofishing surveys.

5.3.6 Fry Outmigration

Juvenile fish movement through RSW, the Rascal Fishway, and upper RSE prior to winter freeze-up will be monitored using bi-directional fyke nets. Four nets will be installed from early- to mid-July until freeze-up (~early October) at the same locations as the fish boxes (Figure 5.3-1; Table 5.3-1). Each fyke net will be serviced once a day during peak outmigration, and once every two days after peak migration. During each visit, all fish will be counted, identified to species, sub-sampled for length and weight, and released in the direction they were swimming. Fyke nets will allow for the determination of movement patterns and evaluation of fish passage by Arctic Grayling fry and juvenile fish, as well as their stream residence time and total growth of fry during their stream residence. It will also provide information as to lake preferences for overwintering habitat.

5.3.7 Culvert Passage Assessment

An assessment of upstream passage through the culvert will be completed to ensure that the culvert does not restrict access for fish. A box trap will be installed immediately upstream of the culvert in Year 2 to assess fish movement. Catch at this trap will be compared to the catch at the fish box net located at the inflow to Goose Lake (Site MS9; Section 5.3.6), downstream of the culvert.

5.3.8 Evaluating Success of the Fish Passage Mitigation

Data collected during the monitoring program will be used to evaluate the success of the fish passage mitigation.

The fish passage mitigation will be considered successful if: 1) Flow data consistently demonstrate appropriate habitat conditions for migration of all life stages of Arctic Grayling, 2) Adult fish migration and fry outmigration surveys confirm suitable fish passage through the Rascal Fishway and post-mitigation RSW, and 3) Fish habitat and community surveys confirm continued suitability/use of post-mitigation RSW and upper RSE by fish species and life stages observed during baseline studies.

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REFERENCES

1985. *Fisheries Act*, RS. C. F-14.

B.C. Ministry of Forests, Lands and Natural Resource Operations, B.C. Ministry of Environment, and Fisheries and Oceans Canada. 2012. Fish-stream crossing guidebook. Rev. ed. For. Prac. Invest. Br. Victoria, B.C.

DFO. 2007. DFO Nunavut Operational Statement: Culvert Maintenance. Version 3.0, DFO/2007-1329.

DFO. 2013a. Fisheries Protection Policy Statement. http://www.dfo-mpo.gc.ca/pnw-ppe/pol/index-eng.html. Accessed October 27, 2016.

DFO. 2013b. Measures to Avoid Causing Harm to Fish and Fish Habitat. http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html. Accessed October 31, 2016.

Hubert, W.A., R.S. Helzner, L.A. Lee and P.C. Nelson. 1985. Habitat suitability index models and instream flow suitability curves: Arctic grayling riverine populations. *U.S. Fish and Wildlife Service Biological Report* 82(10.110), U.S. Department of the Interior, Washington, D.C., USA.

Larocque, S.M., C. Hatry, and E.D. Enders. 2014. Development of habitat suitability indices and bioenergetics models for Arctic grayling (*Thymallus arcticus*). Can. Tech. Rep. Fish. Aquat. Sci. 3097: 57 p.

Rescan. 2012a. *Back River Project: 2011 Hydrology Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012b. *Back River Project: 2012 Hydrology Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, BC.

Rescan. 2012c. *Back River Project: 2011 Fish And Fish Habitat Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012d. *Back River Project: 2012 Fish and Fish Habitat Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012e. *Back River Project: 2012 Freshwater Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2014a. *Back River Project: 2013 Fish and Fish Habitat Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd., an ERM Company: Vancouver, BC.

Rescan. 2014b. *Back River Project: 2013 Hydrology Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd., an ERM company.

Rescan. 2014c. *Back River Project: Fisheries Assessment of Rascal Stream Re-alignment*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd., an ERM company.

Sabina. 2015. *Back River Project: Final Environmental Impact Statement*. Prepared by Sabina Gold & Silver Corp.

Scott, W. B., and E. J. Crossman. 1973. *Freshwater Fishes of Canada*. Oakville, ON: Galt House Publications Ltd.

Stewart, D.B., N.J. Mochnacz, J.D. Reist, T.J. Carmichael, and C.D. Sawatsky. 2007. Fish life history and habitat use in the Northwest Territories: Arctic Grayling (Thymallus arcticus). Can. Manu. Rep. *Fish. Aquat. Sci*. 2797.